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NAVAL POSTGRADUATE SCHOOL

MONTEREY, CALIFORNIA

THESIS

MEDICAL OPERATIONS CENTERS: DUPLICATION OR A NEEDED INNOVATION?

by

Michael F. Murphy

December 2009

Thesis Advisor:	Robert Bach
Second Reader:	Glen Woodbury

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13. ABSTRACT (maximum 200 words)

The medical system in the United States is comprised of many different agencies and organizations that need coordination in order to provide optimal care for individual patients created by a mass-casualty incident or public-health emergency. This coordination of all the medical system components has been a challenge in the past, and the medical operations center (MOC) has been one relatively new concept utilized by some jurisdictions to address that challenge.

The public-health system, in contrast to the medical system, focuses on the care provided to the entire community or large population group. Are the two systems different? Are they mutually exclusive? Can the medical operations center meet the coordination needs of the medical community?

This thesis uses surveys of medical system leaders and a qualitative analysis of focus group discussion from jurisdictions currently using an MOC. The thesis begins with a description of the medical system and the challenges that currently exist for coordination and response. Collaboration barriers and facilitators are discussed along with the difference between the two systems. A section of the thesis examines the origins and current functions of four existing medical operations centers in Oklahoma City, Tulsa, Houston, and San Antonio.

The findings support the argument that the two systems are indeed different, but not mutually exclusive. The data also strongly support the MOC as a means of coordinating the medical system if done in concert with public-health agencies.

The thesis concludes with a proposal, conceptual design, and argument to build a national network of medical operations centers in order to enhance the medical system response to a mass-casualty incident or public-health emergency.

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MEDICAL OPERATIONS CENTERS: DUPLICATION OR A NEEDED INNOVATION?

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Submitted in partial fulfillment of the
requirements for the degree of

MASTER OF ARTS IN SECURITY STUDIES
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from the

NAVAL POSTGRADUATE SCHOOL
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ABSTRACT

The medical system in the United States is comprised of many different agencies and organizations that need coordination in order to provide optimal care for individual patients created by a mass-casualty incident or public-health emergency. This coordination of all the medical system components has been a challenge in the past, and the medical operations center (MOC) has been one relatively new concept utilized by some jurisdictions to address that challenge.

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The findings support the argument that the two systems are indeed different, but not mutually exclusive. The data also strongly support the MOC as a means of coordinating the medical system if done in concert with public-health agencies.

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TABLE OF CONTENTS

I. INTRODUCTION....1
A. PROBLEM STATEMENT....1
B. RESEARCH QUESTION....2
C. LITERATURE REVIEW....3
D. ARGUMENT....8
E. SIGNIFICANCE OF RESEARCH....16
F. METHODOLOGY....18
1. Survey....18
2. Focus Groups....20
3. Interviews and Conversations....21
4. Personal Experience....21

II. THE CURRENT MEDICAL SYSTEM....23
A. MEDICAL SYSTEM COMPONENTS....23
1. Hospitals....24
2. Emergency Medical Services....25
3. Long-Term Care Facilities....28
4. The Physician Community....29
5. Other Medical-System Components....30
B. THE MEDICAL SYSTEM AS A NETWORK....31
C. MEDICAL SYSTEM CHALLENGES....33
D. AUTHORITIES AND RESPONSIBILITIES FOR COORDINATION....38
E. CURRENT MEANS OF COORDINATION....40
F. ANALYSIS....43

III. COLLABORATION AND THE MEDICAL/PUBLIC-HEALTH SYSTEM NEXUS....49
A. COLLABORATION....49
B. THE MEDICAL AND PUBLIC-HEALTH SYSTEM NEXUS....56
C. ANALYSIS....61

IV. EXAMINATION OF CURRENT MEDICAL OPERATIONS CENTERS....65
A. OKLAHOMA CITY....65
B. TULSA....68
C. SAN ANTONIO....70
D. HOUSTON....73

V. PROPOSAL FOR A NATIONAL MOC NETWORK....77
A. LEADERSHIP....78
B. AUTHORITIES....82
C. MOC FUNCTIONS....83
1. Primary Point of Contact....84
2. All-Hazards Approach....84
3. Situational Awareness....85

a. Common Operating Picture 85
b. Intelligence 86
c. System Assessment 86
4. Communication Pathways 88
5. Patient Distribution 89
6. Resource Coordination 89
7. Response Solutions 90
D. SYSTEM DESIGN 91
1. Geographic Scope 93
2. Location 93
3. Costs and Funding 96
4. Staffing 99
5. Planning and Operational Guidelines 100
6. Information Management Network 106
7. What is in a Name? 107
E. WHAT THE NETWORK WILL LOOK LIKE 108
1. The Regional MOC 108
2. The State-Level MOC 109
3. The Federal MOC and the Overall National Network 110
VI. CONCLUSION 115
VII. RECOMMENDATIONS FOR FURTHER RESEARCH 121
LIST OF REFERENCES 123
INITIAL DISTRIBUTION LIST 129

LIST OF FIGURES

Figure 1. The Oklahoma City MERC during an exercise. (Photo by Mike Curtis, used with permission.) 67
Figure 2. The Tulsa MERC. (Photo by Johnnie Munn, used with permission.) 70
Figure 3. The San Antonio RMOC during a hurricane exercise in May, 2008, showing the hospital coordination tables. (Photo by Mike Curtis, used with permission.) 72
Figure 4. The Houston Catastrophic Medical Operations Center (CMOC). (Photo by Mike Curtis, used with permission.) 75
Figure 5. Proposed Network of MOCS Aligned with Medical System Response 104
Figure 6. The Regional MOC 109
Figure 7. The State-Level MOC 110
Figure 8. The National MOC Network 112

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LIST OF TABLES

Table 1. Survey Respondent Jurisdiction Population. 19
Table 2. Survey Respondent MMRS Housing Agency. 20
Table 3. Focus Group–Identified Medical System Components. 24
Table 4. CMS Definitions of EMS Providers. 27
Table 5. Percentage of Either "At Capacity" or "Over Capacity" by Hospital Type 36
Table 6. Number of ED Visits/Year, Number of Emergency Departments/Year....37
Table 7. Local Jurisdiction and Regional Agencies with Authority/Responsibility for Medical Response Coordination 39
Table 8. Local Medical Response Element Coordination....40
Table 9. Number of Medical System Seats in Local EOC....41
Table 10. Respondent Opinion on Adequacy of Number of EOC Seats 42
Table 11. Primary Agency Operating Separate Medical Operations Center 43
Table 12. Location of Medical Operations Center If Away from an EOC 43
Table 13. Ranked Impact of Positive Collaboration Factors. 55
Table 14. Rating Impact of Barriers to Establishment of MOC. 56
Table 15. Is There a Distinct Difference between the Medical System and the Public-Health System? 58
Table 16. Strength of Opinion That Systems Are Different 59
Table 17. Strength of Opinion That Systems Are the Same 59
Table 18. Opinion on Separating an MOC from a Public-Health Operations Center 60
Table 19. Opinion on Separation of ESF-8 61
Table 20. Sample HOSS Form. 87
Table 21. Current MOC Names 107

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I. INTRODUCTION

On May 3, 1999, Alan Paxton[1] sat in an outpatient side room at Hillcrest Hospital, slowly dying in plain sight. He, along with over 100 others, had been a victim of an F-5 tornado that struck Oklahoma City, and he had been initially screened as a minor injury. Mr. Paxton was transferred to an overflow area of the heavily affected Hillcrest Hospital and monitored by staff nurses from the medical/surgical floor who were unfamiliar with trauma assessment. Only when he passed out from internal bleeding did the staff realize that something was amiss. Meanwhile, 24 emergency nurses reported for duty at Mercy Hospital located 12 miles from the same affected area. They had responded to their hospital's disaster declaration but treated only eight minor injuries. They spent most of the time watching the events unfold on the television.[2]

Could Hillcrest Hospital have benefited from the expertise and services of the underutilized nurses at Mercy? Would the Mercy nurses have come to assist if requested? Would Mr. Paxton have fared better if emergency nurses skilled in assessing subtle but life-threatening injuries had monitored him? The answer to these questions is a resounding yes. Unfortunately for Mr. Paxton, there was no coordinating mechanism in place to let Hillcrest Hospital know of the available resource or to let Mercy Hospital know of the need. Fortunately for Mr. Paxton, his deteriorating condition was noticed, and he belatedly received the attention and treatment his condition required. His experience, however, points out the potential benefit of a functioning medical system coordinating structure during a mass-casualty incident.

A. PROBLEM STATEMENT

One of the main goals of Al Qaeda and other terrorist organizations threatening the United States is to create mass casualties during an attack as part of their overall plan to instill fear and panic into the general population. The United States is also subject to

[1] The patient's name has been changed to protect his identity.

[2] Karl Lafoon, Charge Nurse, Hillcrest Hospital Emergency Department, interview by author, June 13, 1999, Oklahoma City, OK.

numerous natural and industrial disasters that have the potential to create a large number of killed and injured people. The highest priority for Homeland Security's prevention and response activities is to stop, mitigate, and effectively respond to incidents that directly threaten the life and safety of our citizens.

These factors should place the local and state medical systems in the forefront of Homeland Security prevention and response strategies. Homeland Security Presidential Directive 21 (HSPD-21), released in October 2007, acknowledges the importance of a robust capability within the medical systems around the country. Yet, a cursory review of past incidents shows a repeated lack of coordination and integration within the medical communities during a large incident involving a significant number of casualties.

The medical system, defined by HSPD-21, is a complex collection of organizations and entities that provide care to individual patients. These organizations include, but are not limited to, EMS agencies, hospitals, long-term care facilities, rehabilitation centers, mental health centers, and dialysis units. Most of these facilities are located within the private sector, compete financially with each other, and face daily challenges of providing service to their patients. Yet, during a mass-casualty incident, these disparate components of the medical system must come together and address a sudden surge of patients.

There may need to be some type of entity or system to facilitate the integration and coordination of these disparate organizations in order to ensure that the victims of a terrorist attack, natural disaster, industrial accident, or evolving public-health emergency receive the optimal level of care.

B. RESEARCH QUESTION

Should a medical system coordination entity such as a medical operations center (MOC) be established at the local, state, and federal level to meet the integration and coordination needs of the medical community during a mass-casualty incident?

In order to answer the primary research question, I will need to address several other corollary questions:

What constitutes the “medical system” and what challenges does the system face during a mass-casualty incident or public-health emergency?

Where would these centers be located, who would operate and fund them, and what potential challenges could be encountered during their creation?

What would be required to facilitate effective collaboration among the different organizations?

What functions would such centers perform?

How could the difference between individual-based care performed by the medical system and the population-based care performed by public-health agencies affect implementation and functionality?

C. LITERATURE REVIEW

While incidents creating mass casualties have occurred throughout our nation’s history, recent natural disasters, identified problems with an aging infrastructure, and the specter of terrorism creating acts of mass lethality have demonstrated an increased likelihood and frequency of incidents that will stress the medical response system. The current medical system is extremely fragile and operates within an environment of reduced capacity, marginal profits, and questionable survival. While the threat is increasing, the capability to respond faces stronger challenges every year.

The purpose of this thesis is to determine whether there is a need for a medical system coordination entity at the local and regional level in order to facilitate the optimal utilization of medical system resources. Part of that determination involves understanding the definition and components of the medical system as well as its organizational structure and behavior. There must also be a demonstrated need for coordination and communication, and a study of current models should be undertaken. The actual or perceived barriers encountered by these current models, and their relative success or failure also factor into the determination of need.

The availability of relevant literature varies depending on the investigated factor from the list above. Several compelling studies, reports, and directives demonstrate the need for a robust medical system that can respond to a disaster.

There are certainly common perceptions of what comprises the "medical system" in the United States, but the literature provides few clear definitions in the context of disaster preparedness and response. Most documents addressing disaster response tend to include the medical system in the general context of public health. This may result from a view that the majority of the medical system components are private for-profit organizations regulated by federal or state public-health agencies. Another cause for this conclusion may arise from describing desired goals for the resolution of a disaster. The language tends to focus on the community aspect (a public-health venue) instead of addressing the needs of any particular individual. The majority of medical and public-health funding programs at the national level, and the grant guidance that accompanies them, originate from the public-health-centric U.S. Department of Health and Human Services. All of these factors may explain the lack of separation between public-health and medical systems in the literature.

There is a need to separate the medical system from the public-health system because the two are different entities and often have different needs, responsibilities, and areas of operation. A general tension exists between the two systems that can translate into challenges when situations require the medical needs of the community to be addressed during a disaster or public-health emergency. The differences can create an interesting dichotomy: two distinctly different systems whose overall goal is the health of an individual, and collectively, the health of society.

Fortunately, there is some recognition in the literature of the differences. The recent Homeland Security Presidential Directive 21 actually differentiates between the two systems by defining "medical" as the "science and practice of maintenance of health and prevention, diagnosis, treatment, and alleviation of disease or injury and the provision of those services to individuals" (emphasis added).[3] The directive further

[3] The White House, *Homeland Security Presidential Directive 21*.

defines “public health” as “the science and practice of protecting and improving the overall health of the community through disease prevention and early diagnosis, control of communicable diseases, health education, injury prevention, sanitation, and protection from environmental hazards” (emphasis added).[4]

For-profit institutions seeking reimbursement from federal and state programs such as Medicare and Medicaid seek accreditation by an external organization. A review of the numerous standards and guidance documents from the largest accreditation organization also helps define the components of the medical system. The standards cover hospitals, clinics, physicians’ offices, long-term care facilities, assisted-living centers, dialysis units, and mental-health institutions.[5] Emergency Medical Services (EMS) utilizes its own accrediting bodies and would be included due to the individual patient services it offers.

An excellent reference to demonstrate the difference between public health and the medical system components is Laurie Garret’s 2000 book entitled *Betrayal of Trust: The Collapse of Global Public Health.*[6] She spends an entire chapter describing the 200-year evolution of both public-health and medical-care systems in the United States. She describes the differences and the origins of both systems and demonstrates how public health and medical care can actually be at odds with one another. For the purpose of this thesis, the discussion will focus on those components that provide medical and health services to individuals and will not address the community public-health aspect. While the two are different, they are not mutually exclusive. In fact, success in one area very often determines the success in the other.

The organizational structure and behavior of the medical system during an emergency may help identify mechanisms needed to facilitate coordination. Two questions arise about the system. Is the system a network and subject to established relationships and lines of authority? Is the system adaptable and able to function in the

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[4] The White House, *Homeland Security Presidential Directive 21*.

[5] Joint Commission, “Accreditation Programs.”

[6] Garrett, *Betrayal of Trust.* See especially 268–486.

rapidly changing environment that accompanies a disaster? There is a significant amount of literature to demonstrate that the medical system is a network. In fact, many health-care facilities advertise and advocate their involvement in networks. One article points out how networked organizations actually require more coordination: "Because the members of network organizations come from various backgrounds, most alliance coalitions or networks are unstable. Also, due to the 'vague network' found between different organizations, it is required for much more coordination and integration here."[7]

In most areas of the country, the medical system tends to center around clearly identifiable hubs located in major urban areas or major universities. While it is relatively easy to show the network aspect of the medical system, it is far more difficult to addresses just how that network reacts during a disaster. The literature is relatively silent on the medical network response to disaster.

The literature surrounding adaptive systems and the medical system is also relatively sparse. One can assume that the medical system is complex and adaptive, particularly to changes in payment mechanisms, clinical improvements, and regulatory requirements. What is lacking in the literature is just how quickly the system can adapt to a sudden change. Perhaps a review of past incidents involving disasters can shed some light on the capability of adapting quickly.

A retrospective analysis of past mass-casualty incidents is one available method to determine the need for medical coordination. Such a review can help determine any consistency in the success or failure of medical-system coordination and communications. Fortunately, the literature is replete with after-action reports from various incidents in the nation's past.

The hospital system in south Florida formed "buddy systems" after hurricane Andrew in 1992.[8] Oklahoma City hospitals were "working in silos" during the Oklahoma City Bombing but have since "formed an agreement in which they agree to share

[7] Hu, Yang, and Chou, "Classifying Healthcare Network Relationships," 670.

[8] Sabatino, "Stories of Survival," 26.

resources, personnel, and time with the neediest of hospitals."[9] One of the recommendations following hurricane Katrina in New Orleans was "developing effective and resilient communications systems."[10] Exercise after-action reports, available in plentiful supply, can also supplement the reviews from previous incidents. Both these types of reports can show either where the need for a coordination entity existed or where a coordination entity in place actually facilitated effective patient disposition and care.

An area that remains unexplored and unknown is the number of cities that already have medical-system coordinating centers in place. The literature does have sporadic descriptions of systems that have created an enhanced capability to coordinate the medical system, but there is no over-arching and comprehensive review of the national status of these centers. Anecdotally, we know that centers exist in San Antonio, Houston, Oklahoma City, and Tulsa. We also know that Virginia, California, New Jersey, and North Carolina have taken steps to facilitate medical system coordination. The overall picture is incomplete.

As expected, few studies address the challenges and barriers that may be present should a jurisdiction decide to design and implement a medical operations center. Nitin Natarajan published a thesis from the Center for Homeland Defense and Security that outlines the need for, and the potential challenges to, the formation of a Domestic Medical Intelligence Center.[11] In that paper Mr. Natarajan discusses some of the functions of the proposed centers. Since situational awareness relies on intelligence, many of his observations and conclusions will have relevance to the subject of medical operations centers.

In 2006, Upton, Frost, and Havron described the Houston medical-system experience and the creation of a unified medical command infrastructure during hurricanes Katrina and Rita. They state, "During a disaster, a unified approach to medical

[9] Meyers, "Disaster Preparedness," 12.

[10] Rodriguez and Aguirre, "Hurricane Katrina and the Healthcare Infrastructure," 13.

[11] Natarajan, "National Imperative to Establish a Domestic Medical Intelligence Center."

command provides rapid facilitation of patient triage and placement in appropriate facilities, coordinates with local, regional, state and federal initiatives, and helps ensure a stable medical infrastructure."[12]

In early 2007, Maldin et al. published an article titled "Regional Approaches to Hospital Preparedness" in the journal *Biosecurity and Bioterrorism: Biodefense Strategy, Practice, and Science*. In that article, the authors discuss research findings regarding regional coordination for hospital preparedness. One of the recommendations in the article was that "key operational functions of regional groups include the ability to coordinate the transfer, deployment, and distribution of patients, staff, and supplies and to make decisions regarding scarce medical resources and altering standards of care."[13]

There is a significant amount of published literature on the challenges that may confront the medical system during a disaster. There have also been proposed command and control processes that address the response to meet those challenges. Two separate groups of work have provided invaluable input into the thesis research. Dr. David Hogan, a practicing physician in Oklahoma City, has published research on medical disasters for years and is the editor of the definitive text on disaster medicine.[14] Drs. Barbera and Macintyre, both emergency physicians, first developed an incident management–system process for medical and public-health coordination,[15] and then expanded their work into a comprehensive document that identifies processes and issues for both medical system preparedness and response.[16] They stop at describing just how to do it, hence, the need to further the process with additional work.

D. ARGUMENT

Recent disasters that created mass casualties or compromised the health-care system have demonstrated the need for better medical coordination. The patient

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[12] Upton, Frost, and Havron, "Operationalizing a Regional Unified Medical Command."

[13] Maldin et al., "Regional Approaches to Hospital Preparedness."

[14] Hogan and Burstein, *Disaster Medicine*.

[15] Barbera and Macintyre, *Medical and Health Incident Management (MaHIM) System*.

[16] United States Department of Health and Human Services, *Medical Surge Capacity and Capability*.

distribution from the Oklahoma City bombing in 1995 resulted in an inordinate number of patients sent to the nearest hospitals, while large facilities a few miles farther away received proportionally far fewer patients.[17] In 1996, Tulsa hospitals remained in disaster mode awaiting patients long after public safety agencies had cleared the scene. Public safety agencies failed to notify the hospital system that the threat had passed with relatively few injuries.[18] The after-action report from the Oklahoma City tornado of May 3, 1999, highlighted the fact that hospitals had acted as isolated islands with little communication and resource sharing.[19] During the World Trade Center attack in 2001, most of the patients went to two nearby hospitals while a Level-1 Trauma Center three miles away stood idly by because there were no patients from the incident to treat at their location. Meanwhile, the two closest hospitals were overwhelmed with patients.[20] During an arsine release in Tulsa, some hospitals admitted exposed patients for observation while other facilities released patients after an initial exam; this was a clearly inconsistent pattern that could have resulted in legal liability had there been a negative outcome for one of the released patients.

During hurricane Katrina, the compromised hospitals in New Orleans had no means of communicating. [21] The Louisiana Hospital Association representative in the State EOC in Baton Rouge had one seat, was overwhelmed, and found it hard to determine what was going on in the New Orleans hospital system. The thousands of evacuees relocated to Houston created such a demand on that city's medical system that Houston emergency management established a specific medical coordinating center right in the city's EOC. There appears to be a strong record from past disasters that demonstrates the need for improved coordination and communication.

---

[17] Kellison et al., "Immediate Hospital Impact of the Oklahoma City Bombing."

[18] Tulsa Catoosa debriefing meeting, EMSA Headquarters, April 23, 1996.

[19] Tornado Medical Response after-action meeting, Greater Oklahoma City Hospital Council, June 13, 1999.

[20] Simon and Teperman, "The World Trade Center Attack."

[21] Association of State and Territorial Health Officials, "A Summary of Four After-Action Reports on Hurricane Katrina."

The current threat to Homeland Security also provides support for the importance of medical system coordination. The new, unconventional threat and asymmetric warfare doctrine demonstrated by the various components of Al Qaeda and its sympathizers has two chilling aspects: disregard for the lives of its proclaimed enemy and an actual desire to create mass casualties by design.

The Oklahoma City bombing demonstrated that domestic terrorists are willing to create mass casualties. Even though the domestic threat has transitioned to issue groups who attack structures and buildings, these attacks are showing a pattern of increased lethality. The specter of chemical, nuclear, and biological attacks raises the risk of mass-casualty incidents even higher.

A current public-health concern is a pandemic influenza virus that infects an enormous number of patients, overwhelms the medical system, and creates severe shortages of available resources. Recent disasters, such as the Gulf hurricanes of 2004–2005 and the tsunami in the Indian Ocean, demonstrate how acts of nature can overwhelm a medical system.

Our society has become increasingly dependent on a critical infrastructure that is aging and vulnerable to attack. Hospitals and medical system components are very dependent on water, power, supply distribution networks, and information technology, all of which can be compromised by an attack or natural disaster. The medical system itself is critical infrastructure that is very vulnerable and wrestling with the issue of open access to patients and protection measures.

In today's environment, the threat of a mass-casualty incident is real. While one may speculate on the specific likelihood of an incident, and talented, dedicated people are working tirelessly to prevent such an incident, the failure to develop innovative means to respond to such an incident would be a violation of the trust of the American people. The medical operations center is one such innovative approach that should be recognized and instituted throughout all the major metropolitan areas in the country.

Homeland Security Presidential Directive 21, released October 18, 2007, establishes a national strategy for public health and medical preparedness. Besides

differentiating between the medical-system and public-health response activities mentioned above, the directive also contains key elements that support the establishment of medical operating centers. Under the background information the directive states, "The assumption that conventional public health and medical systems can function effectively in catastrophic events has, however, proved to be incorrect in real-world situations." [22] The directive follows with the statement that "the United States has tremendous resources in both public and private sectors that could be used to prepare for and respond to a catastrophic health event. To exploit those resources fully, they must be organized in a rationally designed system that is incorporated into pre-event planning, deployed in a coordinated manner in response to an event, and guided by a constant and timely flow of relevant information during an event."[23] The medical operations center can provide the needed coordination and timely flow of relevant information. The directive also points out, "Collectively, our Nation must develop a disaster medical capability that can immediately re-orient and coordinate existing resources within all sectors to satisfy the needs of the population during a catastrophic health event."[24]

While some may argue that the directive only applies to federal agencies, the actual medical care for individuals is provided at the local and regional level. Hence, the issues addressed in the directive apply to the local and regional level, and the medical operations center is one element of an effective disaster-relief medical system required by the directive.

The current medical coordination system in many cities may prove ineffective. This traditional system usually involves coordinating medical and public-health response activities from one or two seats in an emergency operations center (EOC). This small component usually has to coordinate the activities of the EMS system, the local public-health agency, the hospital system, and any other components of the medical system response. The hospital system alone can present enough challenges to overwhelm one or two people. Some individual facilities employ more personnel than all that jurisdiction's

[22] The White House, *Homeland Security Presidential Directive 21*.

[23] Ibid.

[24] Ibid.

public-safety agencies combined. Coordinating the response activities of numerous large facilities, combined with public health, EMS, nursing homes, and physician clinics will take a dedicated and trained team instead of one or two individuals. The past system "worked" only because the medical system as a whole went uncoordinated. In today's threat environment, that is no longer acceptable.

Information is a critical component for any agency or organization responding to a large incident, and the medical system's need is no different. In the past, components of the health-care system frequently operated in an information vacuum. They often acted as isolated islands, treated the patients as they arrived, and did the best they could with the resources available. Hospitals in particular need information from the scene in reference to the type of incident, the total number of patients, the type and severity of injury, and any patient contamination. Hospitals can often identify the class or nature of a chemical contaminant based upon patient symptoms, and they need a way to communicate those findings to the hazardous materials units working the scene. While there frequently is some form of information exchange between the EMS agency and the hospitals, that information is often spotty and unfocused.

Hospitals need to understand the bigger picture in order to determine the impact of a disaster on the facility itself and to make operational adjustments. This problem is not unique to the United States. One of the key findings of a large chemical exercise held in Australia in 2003 was a need to "enhance communications with other emergency services and hospitals."[25] A review of the medical response to the London Subway bombings in July 2005 found that "all hospitals involved were reliant exclusively on media broadcasts and one-way communication from the scene via emergency services."[26]

Ensuring that resources are available is another critical component of any large-scale medical response. The MOC can also serve a unique coordination role by collecting the various equipment and supply needs of the medical community. It can dispatch

[25] Edwards et al., "Truth Hurts."

[26] Lohn, Fong, and Whithey, "Medical perspective on mass casualty trauma," 36–38.

resources from a cache, facilitate the transfer of loaned equipment, or communicate the needs to emergency management for procurement.

Following the attack on the World Trade Center and the subsequent grounding of all aircraft, there was a concern that the hospital system might run short of supplies. Hospitals and other medical facilities keep a very low inventory level of supplies and depend on daily shipments of ordered equipment and consumables. The actions taken following 9/11 disrupted that supply chain. The Oklahoma City MERC communicated with hospitals and was able to find local sources in the medical system for some supply shortages encountered by several hospitals.

In many circumstances, additional qualified and experienced health-care personnel respond to fill a need during a mass-casualty incident or public-health emergency. The medical system routinely runs at or near full capacity and is chronically short of personnel. A disaster exacerbates an already difficult situation. The additional patient load can readily overtax the already stressed health-care providers, who will need additional help in order to continue providing an acceptable level of care. Disaster leaders can find space and equipment, but it is far more difficult to locate additional personnel.

There are potential sources for work force augmentation: Medical Reserve Corps personnel, state and federal agency personnel, private contractors, or, as in the case study presented at the start of this discussion, hospital personnel from an unaffected facility. The challenge will be to identify the personnel needs of the facility and match those needs with the supply of available personnel. This challenge will be even more difficult if the disaster scenario occurs where multiple facilities have staffing needs and are competing for the same workforce pool. The optimal way to prioritize and coordinate staffing augmentation is through a centralized coordinating entity such as the MOC.

There may be other operational needs filled by a functioning and staffed medical operations center. The MOC may also serve as a call center for various medical-system components. This call center responsibility can range from a regular daily function such

as a patient distribution center to a central location for Medical Reserve Corps volunteer coordination. The type of incident and the particular challenges presented would dictate the specific role an MOC will play.

In December 2007, Oklahoma City experienced an ice storm that resulted in more than one million people being without power. The Medical Emergency Response Center, the Oklahoma City MOC, activated to coordinate the needs of the hospitals and EMS.

Surprisingly, the role of the MOC changed drastically during the initial days of the disaster. The hospital and EMS system were stressed but functioning without the need of much assistance. The real need turned out to be the individuals at home with medical devices such as O2 generators or nebulizers that needed power. The 211 center became flooded with calls from patients needing help; it transferred the calls to the MOC. For six days the MOC coordinated resources to get oxygen to the homebound, arranged EMS transport for those unable to stay in their homes, and assisted with the establishment of a special shelter for medical needs at the Cox Convention Center.[27]

The MOC can also serve as a liaison to the federal and state agencies arriving in a city to render assistance. One of the most urgent needs for these agency personnel is situational awareness and mission coordination. A functioning MOC will be able to provide both. The MOC can also provide an upward flow of information to state and federal agency command centers to give a concise and timely picture of the current situation and the medical needs of the community. The centralized feature of MOC can provide a "one-stop" location for various agencies and teams requiring current medical system information.

The MOC would not duplicate existing command and coordination centers. The intent of the MOC concept is to augment the existing response mechanism and provide a capability that has been missing in the past. The MOC actually expands the Emergency Operations Center by providing enough space to allow all the activities that are required

[27] Author's personal experience in responding to the December 2007 ice storm in Oklahoma City, December 8–19, 2008.

for a coordinated medical system response. In fact, the experience of the few MOC entities existing in the United States has demonstrated the benefits of being co-located with an existing EOC.

Even though HSPD-21 clearly delineates the difference between medical system response and public-health response activities, the two do not have to be mutually exclusive. Many of the activities of both are similar, and the goal of a coordinated medical response translates eventually into the goal of a beneficial public-health response. The MOC and/or public-health EOC can actually include public-health response coordination as well as medical system coordination. An important element of success is the recognition that the medical system has different needs and response mechanisms from the traditional public-health system.

Tracking patients from a disaster provides an example of a mutual benefit for both systems. The MOC can gather the names and locations of injured or ill patients in the health-care system. This information can greatly benefit public health in trying to locate contacts or those ill or exposed to a disease. Some medical facilities refuse to share patient information due to perceived HIPAA restrictions. The clear public-health activity exception provides a means to ease the concern and obtain information.

The creation of a medical operation center will take coordination, buy-in, and funding. Although there will be an associated cost for training and equipment, the cost need not be prohibitive. The space for an MOC can be in an area that has other uses but would become available during an emergency. Staffing can be provided by trained personnel from large facilities that will have a vested interest in having one of their people working in the center. Administrative staff from the host organization can also be trained for a duty station in the MOC during an emergency.

If a permanent and dedicated structure is desired, federal grant programs can be a potential source of funding. The FY 2008 Homeland Security Grant Program and the Health and Human Services Hospital Preparedness Program have at least eight grants that would allow the funding of a medical operations center.

There have been cases of the successful utilization of an MOC during an incident. During the Oklahoma City tornado in 2003, the MERC was able to present situational awareness to the ICS structure, which facilitated effective resource utilization. Shreveport created a spontaneous MOC in a classroom in 2005 to address the coordination needs of Katrina evacuees. Houston, likewise, established an MOC in its EOC to coordinate the medical care of the thousands of evacuees in the Astrodome. Houston also used the MOC to coordinate the needs of medically needy individuals during the hurricane Rita evacuations. The San Antonio MOC coordinated the movement of medical assets in preparation for the landfall of hurricane Dean in 2007. Both Tulsa and Oklahoma City utilized their respective MOCs to address the medical system needs of a crippling ice storm in December 2007.

The after-action report on the hurricane Katrina response identified several failures in the medical response to the catastrophic storm that struck Louisiana, Mississippi, and Alabama. Hospital evacuation, medical volunteer coordination, mass fatality management, interoperable communications, and caring for special populations were some of the areas identified as needing improvement in the future.[28] These were not failures of any particular facility or agency; they were system failures. An entity such as the MOC, which helps coordinate the medical system response, is a step that jurisdictions can take to avoid repeating the mistakes that occurred in 2005.

E. SIGNIFICANCE OF RESEARCH

Since there is a relative paucity of literature addressing the concept of medical operations centers as a tool for coordinating the medical system during a disaster, this thesis will be an addition to the limited body of knowledge on the subject. The answer to the question at hand, and the possible additional questions answered, will provide either an argument against the option of medical operations centers or a collected body of evidence supporting their implementation. This thesis may also serve the purpose of

[28] Association of State and Territorial Health Officials, "A Summary of Four After-Action Reports on Hurricane Katrina."

providing a certain degree of specificity to the generalized needs presented in other works that address the overall medical component to disaster response.

This thesis may not answer all the questions surrounding the issue of medical system coordination and may call for additional research. It will provide a documented effort, background information, options considered, and specific research data on the issue. It will hopefully stimulate additional research to add depth, scope, and specificity to the subject matter.

The thesis may provide a sound basis for the inclusion of the medical operations center as a necessary means of providing the needed coordination for an effective medical system response to a disaster. The network of centers proposed at the end of the thesis may provide a needed communications and coordination capability for the entire nation. Conversely, the thesis may provide a valid, academically based, and vetted source to eliminate the medical operations center concept as an option and allow future researchers a chance to refute, or accept the findings and move on to other options as a subject for research.

The most important beneficiary of the research is the individual patient injured during a terrorist attack or other disaster. If the medical operations center proves a viable option and performs in a way that improves the overall medical system response, then that patient may benefit from rapid and appropriate care as well as a reduction in his or her risk of death.

The individual medical system organizations may also benefit from the implementation of an effective means of receiving information, obtaining needed resources, and managing the individual impact of an incident. This may improve efficiency, reduce costs, and allow for the effective continuation of service by that organization. The overall community and response structure in place to address the incident would also benefit from the successful implementation of any mechanism proven to augment integration and coordination. There may be a heightened awareness of the need for coordination at the local level, and the challenges and solutions presented may save time and effort toward the actual implementation process.

The subject of the thesis will illuminate the present need to address a potential gap in the response capability of the medical system. The thesis also brings out and highlights a potential challenge in the difference between the medical system response and the public-health response, something not known to those outside the medical and public-health disciplines. In the end, homeland security practitioners will have a viable option at their disposal to address a potential need in their community.

F. METHODOLOGY

Because the subject of the thesis topic treads on relatively new ground, I determined that there was a need to use several different research methods: a survey of various jurisdictions around the country, focus groups, interviews, and my own personal experience. The combination of the four methods has led to a body of evidence subject to analysis and available for further research.

1. Survey

The point of contact listed for each of the 124 jurisdictions with an established Metropolitan Medical Response System received a 28-question survey utilizing Survey Monkey. These point-of-contact individuals are responsible for the local medical-system response and would constitute a collective field of expertise on challenges to the medical system response.

The survey questions included the following subjects:

- Jurisdiction demographics and medical system size;
- Current means of medical system coordination;
- Opinions on the following topics:
    - The need for medical system coordination;
    - The adequacy of current mechanisms to address large mass-casualty incidents;
    - Utilizing a medical operations center as a means to facilitate the medical system response;
    - Potential challenges to the implementation of a center;

- Collaborative factors of implementation and integration;
- The medical system as separate and different from the public-health system.

Table 1 shows the breakdown of the survey respondents by the size of his or her jurisdiction. The population of the majority of jurisdictions was in the range of 100,000 to 5,000,000. The MMRS Program uses population (starting with the largest U.S. city) to determine the location of the individual programs, so the jurisdictions surveyed will have a tendency to have a larger population.

Table 1. Survey Respondent Jurisdiction Population.

Survey Respondent Jurisdiction Population	
51,000-100,000	1.7%
101,000-500,000	37.3%
500,000-1,000,000	33.9%
1,000,000-5,000,000	22.0%
Over 5,000,000	5.1%

Table 2 shows an example of the different agency disciplines that currently house the MMRS program and are charged with medical-system response. The preponderance of fire departments likely stems from EMS and/or emergency management run by the fire department in the larger cities. The initial MMRS program created a Medical Strike Team—something more suited to the fire discipline. In cities with a separate emergency management agency, the MMRS Program likely landed in with other preparedness and mitigation programs run by that discipline. The wide variance of agencies means that any entity used for medical system coordination will need to involve significant collaboration and account for the culture's capabilities and the restrictions of the housing agency.

Table 2. Survey Respondent MMRS Housing Agency.

Survey Respondent MMRS Housing Agency (61 Responding Agencies)		
Type of Agency	**No.**	**Percent**
Fire Department	19	31.1%
Emergency Management Agency	18	29.5%
Public Health Department	8	13.1%
EMS Agency	6	9.8%
Homeland Security Agency	3	4.9%
COG/Planning Commission	3	4.9%
Hospital/Medical Association	2	3.3%
Non-Government Organization	1	1.6%
St. Louis STARRS	1	1.6%
Police Department	0	0.0%

2. Focus Groups

Individuals from the following communities that currently have the makings of medical operations centers in place participated in focus group interviews during May and June 2008:

- Houston;
- San Antonio;
- Oklahoma City.

The focus group was interviewed on a variety of subjects:

- Why was there a need for the center?
- What instigated or initiated the creation of the center?
- Is the system networked and adaptable to the point of not needing coordination?
- What were some of the challenges faced?
- How is the center operated and staffed?
- How was the center funded?
- What functions does the center perform?
- What were some of the keys surrounding the successful collaboration?
- What value has the center demonstrated if any?

A qualitative analysis was performed on the transcript for each group in order to determine similarities and supportive evidence for the research questions.

3. Interviews and Conversations

More than 25 individual contacts with survey participants were required during the follow-through with the survey process. Many times these contacts evolved into lengthy conversations, particularly when a jurisdiction representative preferred not to complete the survey, but wanted to provide some input. The conversations are anecdotal, but provide some specific points used to provide support to the other research mechanisms.

4. Personal Experience

The author also brings personal experience to the research work. I have been involved in medical-system planning and integration for over ten years as the director of the Oklahoma City Metropolitan Medical Response System. I have direct disaster response experience as the Medical Branch Director for the Murrah bombing in 1995 and the tornado strikes in Oklahoma City in 1999 and 2003. I have also responded with the Oklahoma 1 D-MAT team to the 1998 ice storm in New York, to hurricane Ivan in 2004 in Pensacola, and to the Superdome during hurricane Katrina in 2005. I have practical experience in trying to coordinate the medical system response from the back of a Ford Explorer. I coordinated the medical response to the May 3, 1999 tornado and later found that 85% of the patients from that incident self-referred to the hospital. While stationed at a special-needs shelter during hurricane Katrina, I participated in daily conference calls with state health department officials who were unable to provide a status on the hospital.

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II. THE CURRENT MEDICAL SYSTEM

A. MEDICAL SYSTEM COMPONENTS

The definition or identification of which agencies, organizations, and businesses compose the medical system is essential for understanding their size, scope, function, and relationship with others. Current challenges to providing care assist in the determination of the need for a coordination entity such as a medical operations center. As mentioned earlier, one of the current working definitions of the medical system in HSPD-21 is given as those entities that provide the "science and practice of maintenance of health and prevention, diagnosis, treatment, and alleviation of disease or injury and the provision of those services to individuals."[29] The Congressional Research Service document, *The Public Health and Medical Response to Disasters: Federal Authority and Funding*, provides an additional description of the elements of the medical system: "A successful medical response is perhaps more complicated, requiring the coordination of several elements, which are variously based in federal, state, or local authority, or in the private sector. These elements are (1) patients, who may require rescue or medical evacuation; (2) a treatment facility, which may be an existing hospital or a field tent with cots; (3) a competent healthcare workforce; (4) appropriate medical equipment and non-perishable medical supplies; (5) appropriate drugs, vaccines, tests, and other perishable medical supplies; (6) a system of medical records; and (7) a healthcare financing mechanism."[30]

The three focus groups provided a list of the agencies and organizations they thought made up the medical system. The three groups all agreed that hospitals, EMS agencies, and long-term care facilities (LTC) were critical components of the medical system. Interestingly, all three groups also included public health, but not without a good deal of dissension among the various members of the group. Through additional discussions, each group identified numerous other agencies and organizations as

[29] White House, *Homeland Security Presidential Directive 21*.

[30] Lister, *The Public Health and Medical Response to Disasters.*

components of the medical system. Table 3 provides a list of the components of the medical system as determined by the focus group participants.

Table 3. Focus Group–Identified Medical System Components.

FOCUS GROUP–IDENTIFIED MEDICAL SYSTEM COMPONENTS		
Emergency Management	Fire Departments	Health Laboratories
Rehabilitation Centers	Military	Clinics
Specialty Hospitals	Surgical Centers	Medical Reserve Corps
Physician Offices	Professional Medical Societies	Blood Banks
Hospital Councils	Non-governmental Agencies	State and Federal Regulators
Dialysis and other Technical Clinical Centers	Regional Medical Councils	Federal Bureau of Investigation

The various components offered by the focus groups are a matter of expert opinion. Even that opinion can fail to paint the total picture of the myriad of agencies and organizations, both private and public, that work together to provide medical care for the individual patient. The Oklahoma City focus group, for instance, was actually hesitant to list the agencies and organizations, arguing that their frequent experience with disasters has proven that what seem to be tangential parts of the system suddenly become either a critical need or an essential asset to address an evolving medical crisis. Despite the number and variance of medical system components, there are several key players that merit further discussion: hospitals, EMS, and long-term care facilities.

1. Hospitals

The hospital system in the United States is a collection of facilities, organizations, networks, and systems that operate in both the public and private sectors to provide definitive medical care to individuals. The hospital and its related care facilities are the initial destination for the severely ill and injured patient and provide the life-saving interventions that dictate the mortality and morbidity of any particular incident. Since saving lives and reducing the extent of injury are the highest priorities for any disaster response, hospitals occupy an extremely important position in relation to all the agencies and organizations responsible for mitigating the effects of a natural disaster or terrorist attack.

There are 5,708 hospitals in the United States. Over 85% (4,897) of these are non-federal, short-term general, or specialty facilities known as community hospitals. Community hospitals can be further broken down into not-for-profit (2,913 or 59%), investor owned for-profit (873 or 18%), and state and local government–owned (1,111 or 23%).[31] There are 213 federal hospitals, 444 psychiatric hospitals, 136 long-term care hospitals, and 18 institutional facilities.[32]

There are 945,199 total staffed hospitals beds in the United States, of which 800,892 (85%) are found in community hospitals. Smaller rural hospitals make up 41% (1,997) of the community hospitals while larger and more capable hospitals located in the urban areas make up 59% (2,900) of the total. Hospital admissions exceeded 37 million patients last year, and the total expenses for hospitals exceed 640 billion dollars.[33]

Rural facilities tend to be smaller with fewer total beds and limited capabilities. They frequently refer patients needing advanced care to the larger facilities in metropolitan areas.

Of the MMRS jurisdictions that responded to the survey, nearly 70% had at least six acute-care hospitals in their jurisdiction. Over 26% of the responding jurisdictions had more than fifteen acute-care hospitals in their metropolitan area. Over 26% of the MMRS respondents also had more than five non-acute specialty hospitals in their respective jurisdictions.[34]

2. Emergency Medical Services

Like the hospital system in the United States, the Emergency Medical Service (EMS) discipline is comprised of numerous types of agencies and organizations that deliver emergency pre-hospital care to the victims of a disaster or public-health emergency. The role of EMS can prove a significant factor in the overall successful

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[31] American Hospital Association, *Fast Facts on Hospitals*.

[32] Ibid.

[33] Ibid.

[34] Survey results available from author.

mitigation of a patient's injuries and/or illness. While the definitive care for a patient usually occurs at a hospital, the EMS provider performs critical lifesaving interventions, rapid transport, and perhaps most importantly, the distribution of the patient to a facility capable of meeting the patient's needs.

There are different levels of clinical licensure for EMS services and units. These licensure levels reflect either the level of clinical practice performed by the patient attendant, or a specialty capability dictated by the type of transport. Each state dictates the level of service and the clinical care provided; hence, there is a wide array of different types of services throughout the county. At the federal level, the typing determined by the benefit payer, and the Centers for Medicare and Medicaid Services (CMS) helps illustrate the different types of EMS services and units.[35]

Table 4 shows the different CMS definitions for the providers of EMS services. EMS involves both public agencies and private corporations. The clinical licensure level varies from a basic emergency medical technician (EMT-B) to a registered nurse (RN) and occasionally, a physician. The vehicles used for transport and response go far beyond the traditional ambulance and include everything from small chase cars to fixed-wing aircraft. The EMS service in the nation is large and quite varied.

There are 15,276 ambulance services in the United States. There are 48,384 ground ambulance vehicles and 840,669 licensed EMS personnel. Fire departments make up 42% of EMS providers. Government service providers outside of the fire department make up 25% of EMS providers. Hospital-based and private companies constitute 20% of providers, while other types (tribal, police) make up the remaining 13% of EMS services.[36]

The EMS services that provide only non-emergency transport may not figure into the daily EMS emergency response, but they do facilitate a significant number of patient transfers. They are a resource during a disaster or public-health emergency to assist with

[35] United States Department of Health and Human Services, Centers for Medicare and Medicaid Services, *Medicare Benefit Policy Manual*.

[36] National Association of Emergency Medical Technicians, *EMS Fast Facts*.

the emergency call volume. Many metropolitan areas also have multiple emergency and non-emergency EMS services working within the same jurisdiction or region.

Table 4. CMS Definitions of EMS Providers.

CMS Definitions of EMS Providers	
EMS Service Category	Category Determinants
Basic Life Support (BLS) non-emergency	Patient ground transportation staffed by an individual licensed at the Emergency Medical Technician-Basic (EMT-B) level. Units do not respond to emergency calls.
Basic Life Support (BLS) emergency	Patient ground transportation staffed by an individual licensed at the EMT-B level who responds to emergency calls and may provide non-emergency transport.
Advanced Life Support (ALS) non-emergency	Patient ground transportation staffed by an individual licensed at the Emergency Medical Technician–Intermediate (EMT-I) level or an Emergency Medical Technician Paramedic (EMT-P). Units do not respond to emergency calls.
Advanced Life Support (ALS) emergency	Emergency response patient ground transportation staffed by an EMT-I or EMT-P. Units may also provide non-emergency transport.
Advanced Life Support (ALS) level 2	An ALS unit that provides three or more medications to a patient or at least one specialized intervention.
Specialty Care Transport (SCT)	Interfacility ground transportation of a patient requiring care beyond the scope of the EMT-P licensure.
Paramedic Intercept (PI)	Units that provide ALS services without providing transportation. Transportation usually provided by BLS services.
Fixed-Wing Ambulance (FW)	Patient air transport provided by an FAA-licensed airplane ambulance.
Rotary-Wing Ambulance	Patient air transport provided by FAA-licensed helicopter ambulance.

Of the 69 MMRS cities that responded to the EMS question on the survey, 82.6% had two or more emergency 911 services operating in their region. Over 26% of the jurisdictions had more than 15 emergency services operating within one region. The same pattern held true with non-emergency EMS services. Over 82% of the cities surveyed had two or more in their area and over 30% had more than six non-emergency providers in their jurisdiction. Coordination of this many EMS organizations would be difficult from the field or an EOC, particularly if the incident covered numerous service areas.

3. Long-Term Care Facilities

Long-term care facilities provide medical and non-medical care to individuals with chronic illness or disability and are part of a continuum of services that include adult day services, home health care, community services, senior housing, assisted-living residences, continuing-care retirement communities, and nursing homes. The vast majority of the residents of these facilities are elderly and in various stages of physical, mental, and behavioral incapacitation. The nature of the incapacities makes this population extremely vulnerable and more reliant on on-site caregivers and the mostly privatized facility owners and operators. The frailty, lack of mobility, and congregate housing of this population also produce significant challenges for response personnel during an emergency—such as a fire or flood—requiring evacuation.

The number of long-term facilities in the United States is large, and the number will grow. By 2026, the population of Americans aged 65 and older will double to 71.5 million. Between 2007 and 2025, the number of Americans ages 85 and older will increase by 40%. Among people turning 65 today, 69% will need some form of long-term care, whether in the community or in a residential care facility[37].

There are 16,100 certified nursing homes in the United States, with a total resident population of 1.4 million. There are 39,500 assisted-living facilities in the country, with a population of 900,000.[38]

Nearly 1.4 million elderly individuals receive some type of home health services.[39] Interrupted service due to a disaster or a weather emergency creates an additional strain on the EMS agencies and hospitals. Home health patients utilize the 911 system in order to obtain the medical care they are now missing.

The long-term facilities in the United States are also seeing “an influx of patients seeking short-term rehabilitative care as cash-strapped hospitals treat and discharge

[37] American Association of Homes and Services for the Aging, “Aging Services.”

[38] Ibid.

[39] Ibid.

patients as quickly as possible."[40] Many nursing homes are reducing the longer-term beds in order to meet this new and more profitable demand.[41] This will have the effect of reducing the number of overall beds for the long-term patients as well as adding a different demographic mix into the current long-term care system.

Sixty-four MMRS cities responded to the survey question asking about the number of nursing homes in their jurisdiction. Slightly less than 82% of the jurisdictions had more than six long-term care facilities in their area. The largest percentage of respondents, 32% (21), had between 26 and 50 facilities. Four jurisdictions (6.1%) had between 151 and 200 long-term care facilities in their response area. The long-term care facilities in many cities are numerous, growing, and present significant coordination and response challenges.

4. The Physician Community

Independently practicing physicians constitute another major element of the medical system in the United States. While many are affiliated with and practice in the hospital system, individual patients receive a significant amount of care in the physicians' offices and clinics that dot the landscape of every American city and town. There are two main groups of medical practitioners in the United States: allopathic (M.D.) and osteopathic (D.O.). Although these two groups have become very similar in recent decades, there are still some subtle differences in their approaches to a patient. M.D.s and D.O.s receive their education and training in different medical school programs and belong to different professional organizations.

Collectively, they number 940,000 physicians, including 62,000 osteopathic physicians, and 223,000 graduates of foreign medical schools who meet the U.S. license credentialing standards.[42] In 2006 there were over 900 million office visits in the United States,[43] roughly three visits for each man, woman, and child in our country.

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[40] Solomont, "Nursing Homes Take on New Roles as Hospitals Struggle."

[41] Ibid.

[42] American Medical Association, "AMA Physician Masterfile."

[43] American Osteopathic Association, "Osteopathic Medical Profession Report."

The physician community outside of hospitals is large, geographically extensive, and carries a significant load of the medical care performed in the United States. Any reduction in that load, such as during weekends and holidays, reverberates through the acute-care hospitals as patients seek out care for what they perceive as urgent medical problems. During a long-term disaster, or public-health emergency, it is important to keep the physician community engaged and informed so they can continue to carry the load of primary and specialized care.

5. Other Medical-System Components

There are numerous other medical system components beyond the key ones just discussed or identified by the focus groups. Some of these include pharmacies, mental-health-care providers, medical suppliers, rehabilitation centers, dialysis units, and home-health-care agencies. The list can be continued with additional agencies, organizations and businesses—each with its unique contribution to medical care and each with its unique role in preparedness and emergency response. Perhaps the Oklahoma City focus group was correct in its hesitation to list components, because a disaster will frequently identify someone not on the list. The recent focus on addressing the needs of the medical special-needs population has added additional entities to the medical-response equation.

During the 2007 ice storm in Oklahoma City, the local medical operations center activated to monitor the EMS agencies' difficulty with call volume and hazardous streets as well as the hospital system's increase in ED call volume. Both those systems were coping well, but when the power to the city was lost, suddenly the MOC was addressing homebound medical patients, dialysis units without power and clean water, and a large shelter operation requiring medical volunteer staffing, medical case management, and pharmaceutical support. During the Oklahoma City bombing, a group of massage therapists offered their assistance to the U.S.A.R. workers returning from a hard shift on the rubble pile. The therapists were approved, and command incorporated them into the incident command structure. Where were they placed? Under the medical branch, their services deemed a clinical support to their clients.

From ICU beds to nursing homes, to massage therapists, the number and variation of agencies and organizations that can potentially be needed to mitigate, respond to, or recover from a large mass-casualty incident is vast. There will need to be a mechanism to coordinate their collective response activities and resources in order to optimize their capabilities; this is a mechanism that may or may not be in place.

B. THE MEDICAL SYSTEM AS A NETWORK

One argument against the need for a medical coordination center is the fact that the medical system is actually a network that will adapt to a changing situation and self-correct any deficiencies. The idea that the medical system is a complex adaptive system is not new; the term "network" routinely winds its way through the medical system lexicon. A medical-care system often advertises the advantage of being part of a greater network of medical-care providers. Insurance companies have networks of physicians. The medical system has demonstrated its capability to change to variations in its internal and external environment. The medical world is constantly changing with new knowledge evolving from practical experience and research. As new knowledge comes in from this evidence-based process, the medical system modifies its practices, processes, and procedures to reflect the new knowledge. The converse is true also; if the evidence shows that it is better not to do something, the system will eventually eliminate that item from all practices.

Perhaps the best example of adaptation in the medical system revolves around the issue of reimbursement. A major source of payment for the medical system is Medicare administered by CMS. When CMS makes changes in the reimbursement structure that provides what is determined to be favorable funding, the medical system will shift to offer more of those services. Currently the care for cardiac patients and those suffering from stroke has a high priority with CMS and consequently has favorable reimbursement rate. That is partially the reason why most medical systems are now emphasizing cardiac and stroke care. Pulmonary problems do not have the current attention of CMS and therefore are not as profitable for the medical system. That helps explain the plethora of

cardiac and stroke advertising and the building of specialized cardiac and neurological hospitals, while specialized pulmonary hospitals are rare or nonexistent.

Potential negative consequences will also create adaptation. CMS recently ruled that it would not pay for care to a pneumonia patient who did not receive antibiotics within four hours of arrival. Now many emergency departments have a "quality assurance" program that tracks and monitors the time between patient arrival and medication administration.

So, if the medical system is a network and the network can adapt to change, then why would there be a potential need for a coordination center? I asked the three focus groups that specific question. All three groups unanimously felt that the health-care system was indeed a network. All three also felt that the system was capable of adapting to the external environment. All three also felt that the adaptation would be too slow and that there was a need for a coordination entity.

The Houston group felt that the adaptation would occur but that it would be slow and uncoordinated, which would preclude the system from making the best use of resources. Feeling as if they were on their own, the Houston hospitals would not have a central location to go for help, and patients might not be placed appropriately based upon their needs.[44]

The San Antonio group also felt that the system is able to adapt in certain circumstances based upon the variables of location, the number of casualties, and the scope of the incident. During a large incident, however, a coordination entity would be needed to facilitate that adaptation.[45]

The Oklahoma City group agreed that the medical system can adapt—that had been demonstrated in the past. [46] Oklahoma City felt that it was a matter of how fast and how well that adaptation occurred. They felt the need for a coordination entity to improve the speed and efficiency of the adaptation. The Oklahoma City group also pointed out the

[44] Houston focus group, May 15, 2008.

[45] San Antonio focus group, May 14, 2008.

[46] Oklahoma City focus group, June 3, 2008.

sheer number of facilities that needed to communicate and the recent JCAHO requirement for facilities to be self-sufficient for the first ninety-six hours of an incident as a reason for a coordination entity. [47]

C. MEDICAL SYSTEM CHALLENGES

Anyone who has recently listened to the news or heard a politician speak understands that the medical system in the United States faces some significant challenges. While a comprehensive examination of all the challenges facing the medical system is beyond the scope of this paper, the reader needs to be aware of some of the more significant problems that will affect an emergency response. Some of these problems include an aging population requiring more services, significant financial impacts, privatization and specialty hospitals, a lack of surge capacity in the nations' emergency departments, and a very troubled EMS system.

As mentioned earlier in my discussion of long-term care facilities, the population of America is aging. There is good news: the financial circumstances, overall health, level of disability, and educational level of the baby boomer is markedly improved compared to the 65-year-old population of twenty or thirty years ago.[48] Still, this movement of the bell curve will require more aging services such as long-term care and geriatric medical specialists. This demographic change will also have a profound effect on the financial status of the health-care system as more and more individuals become eligible for Medicare or require the assistance of Medicaid.

The financial makeup of the medical system is a confusing mixture of government payers (Medicare and Medicaid), third-party payers (insurance companies), non-profits, for-profits, cost-shifting, private specialty facilities, and foundations. There is also a large segment of the population that lacks any means of paying for the expensive costs of health care other than out-of-pocket payment. A look at some hospital statistics will illuminate the financial woes experienced by all medical providers attempting to collect

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[47] Iroquois Healthcare Alliance, "Joint Commission Emergency Management Standards Effective January, 2008."

[48] National Institute of Aging, "65+ in the United States Report."

payment for services rendered. One-third of hospitals lose money on operations.[49] Hospital operating margins average 4%.[50] Medicare and Medicaid represent 55% of the care provided by hospitals, yet Medicare only pays 91 cents for each dollar spent, and Medicaid only pays 86 cents for each dollar spent caring for a patient.[51] In 2006 hospitals provided care to people in financial need at a cost of over $31 billion of care for which no payment was received.[52] The Medicare shortfall for hospital care exceeds $18 billion, and the Medicaid funding shortfall exceeds $11 billion.[53] The lack of recovered costs forces hospitals to shift that cost onto other insurers or make cutbacks that affect the entire community. These cutbacks and the overall financial frailty of the medical system create a very fragile system that is expected to respond to a mass-casualty incident from a natural disaster or terrorist event.

A relatively new phenomenon is occurring in the hospital system today, particularly in states where the government no longer regulates the number or type of hospitals through a certificate of need process: the single-specialty, investor-owned hospital or surgery center. Physicians often own part of these facilities and refer their own patients to these facilities. The net result is a powerful direct competitive force against the large community acute-care hospitals offering trauma services to victims of natural disasters or terrorist incidents.[54]

Physician specialists, such as surgeons, are operating their own facility for their own patients. They no longer have to provide trauma call coverage for the community hospital in return for a location that has the equipment and space for them to practice; they have their own. They are also able to provide their specialty service only for those patients who are capable of paying either through insurance or out of their own pockets.

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[49] American Hospital Association, “Hospital Facts to Know.”

[50] Ibid.

[51] Ibid.

[52] Ibid.

[53] American Hospital Association, “Hospital Facts to Know.”

[54] Hupfeld, “Evolution of the American Hospital System.”

A large terrorist explosion or significant natural disaster will likely produce scores of trauma patients. These patients will receive numerous different injuries affecting different body systems and will require numerous specialists rapidly working at the same time in order to save the patient's life. A patient may have a closed head injury needing a neurosurgeon, a chest injury needing a thoracic surgeon, multiple leg fractures needing an orthopedic surgeon, and burns needing a plastic surgeon. The trauma system in the United States operates on the premise that all of these specialists have to be physically located at the same facility or rapidly respond when called. With specialists operating out of their own facilities, there is no incentive to take call. In fact, there are disincentives present, such as loss of revenue and potential lawsuits. In some communities, hospitals pay upwards of $15,000 in call pay a night to ensure that the right specialists will arrive when needed.

Other systems have cobbled together a system of hospital trauma rotation and staffed call centers to direct trauma patients to the hospital that is providing services for that day. This adds additional costs into the trauma and medical systems. The sporadic and uncertain nature of today's trauma systems creates an environment where EMS needs real-time information on a hospital's capabilities to ensure that the patient is delivered to a facility that has the available specialists to meet the patient's needs.

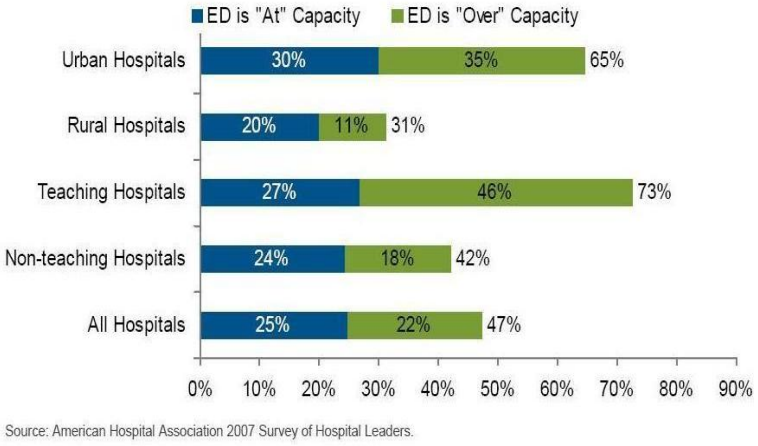
Many of today's hospitals in general, and emergency departments in particular, lack any type of real surge capacity to meet the patient load demands that would be placed on them during a mass-casualty incident. In fact, handling the daily emergency patient volume often overwhelms the nation's emergency departments. In 2007, 65% of urban hospitals and 47% of all hospitals reported that their emergency departments were over capacity. Diversions, at times when the hospital cannot accept additional patients by ambulance, were reported by 56% of urban hospitals.[55] In 2003 U.S. hospitals diverted more than 500,000 ambulances—an average of one per minute.[56]

[55] American Hospital Association, "Hospital Facts to Know."

[56] Bass, Testimony before the Emergency Preparedness, Science, and Technology Subcommittee."

Table 5, from the American Hospital Association, demonstrates that emergency department capacity is an issue regardless of the type of facility considered. Our teaching hospitals, which tend to have additional staff in the form of residents and students, are either at or over capacity nearly 75% of the time. The urban hospitals in this nation, usually an end destination for many rural acute patients, fared little better at 65%. Overall, hospital emergency departments reach or exceed capacity nearly 50% of the time. Based upon these statistics, there is a 50–50 chance that a hospital emergency department will already have capacity issues when a disaster occurs. The coordination of patient destination and resources, in light of the capacity issue, becomes critical.

Table 5. Percentage of Either "At Capacity" or "Over Capacity" by Hospital Type.



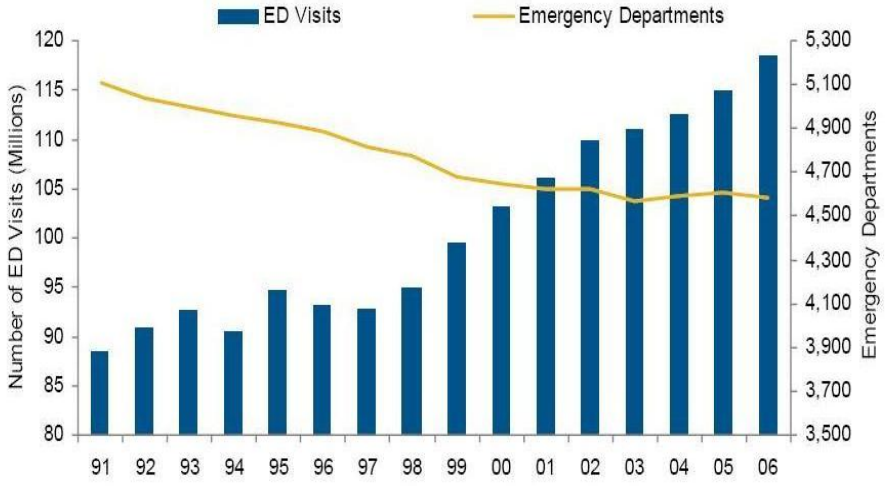
Source: American Hospital Association 2007 Survey of Hospital Leaders.

The capacity and volume challenges to the nation's emergency departments are not getting any better. Each year the situation seems to get worse. Despite efforts on the part of the hospitals to mitigate the challenge, there seems to be an increase in divert hours for the emergency departments. Table 6 provides a graphic demonstration of one of the main reasons that the nation's emergency departments are continually experiencing long wait times, closures, and patient diverts. As the table shows, the number of patients seeking care in an emergency department is steadily on the increase, while the actual number of emergency departments available to provide that care is steadily decreasing. This decrease in available emergency departments is due to hospital closures or the

conversion of former community hospitals with an emergency department to another type of specialty-care facility that no longer offers emergency services to the community.

The situation throughout the rest of the hospital system is not much better. Financial challenges and cost containment have forced hospitals to close units and/or switch resources over to more profitable care modalities. The current shortage of an estimated 116,000 registered nurses has also forced hospital to reduce available beds simply due to the lack of available staff. [57]

Table 6. Number of ED Visits/Year, Number of Emergency Departments/Year.



Source: Avalere Health analysis of American Hospital Association Annual Survey data, 2006, for community hospitals. Defined as hospitals reporting ED visits in 2005 AHA Annual Survey.

The EMS system in the United States is not faring much better. Recent changes in the amount that Medicare will pay for an ambulance transport has resulted in many rural services not being able to meet their costs of providing service. These services either find a subsidy, combine with a fire service, or close their doors. Since the changes went into effect, at least fifty ambulance services have closed in Oklahoma.[58] Even though there has been a 20-year progression of placing the EMS discipline within the fire service, and

[57] American Hospital Association, "Hospital Facts to Know."

[58] Wingrove and Reinert, "Dude, Where's the Ambulance?"

fire departments are the lead EMS agencies in most large metropolitan areas, many fire departments do not focus on evidence-based medicine, outcomes, and cost effectiveness.

Many of the same problems that were present in 1985 are still present today.[59] These problems include the shuttering of EMS services, overutilization of the service for non-emergency calls, sleep-deprived EMS crews, long patient wait times, and an entire field of emergency workers who lack the training to deal with a large-scale catastrophe.[60]

These problems have many origins: lack of a clear federal agency for EMS, lack of state constitutional mandates that are found for fire and law enforcement, low pay, increased call volume, and lack of financial support.[61]

D. AUTHORITIES AND RESPONSIBILITIES FOR COORDINATION

One of the questions surrounding the issue of medical system coordination is "which agency(s) has the legal authority/responsibility for coordinating a medical response?" The answer to that question differs depending on the level of government queried. Legislation and presidential directives provided after hurricane Katrina clearly define the federal authorities. In December of 2006, the president signed P.L. 109–417, the Pandemic and All-Hazards Preparedness Act, which provided that "The Secretary of Health and Human Services shall lead all federal public health and medical response to public-health emergencies and incidents covered by the National Response Plan"[62]

State and local governments, rather than the federal government, are the seats of responsibility and authority for public-health activities, both in general and in response to public-health and medical emergencies.[63] At the state level, legislative mandate and regulatory responsibility has usually placed the legal authority and responsibility with the state departments of health. What is far less clear is the responsibility at the local and

[59] Evans, "Despite Efforts to Date, EMS Problems Remain."

[60] Volk, "Saving America's 911 System."

[61] Ibid.

[62] Ibid.

[63] Lister, *The Public Health and Medical Response to Disasters*.

regional level. At this level, regulatory activities are frequently absent and defer to state regulation. Numerous city, county, and regional agencies potentially could assume responsibility for medical system coordination.

In order to get an idea of which of these agencies has responsibility and authority, I asked this specific question in the MMRS survey: "At the local and regional level, which agency has the legal authority/responsibility for coordinating a medical response (EMS, Hospital, Long-Term Care, and Physician Offices)?" Seventy MMRS Directors representing medical health and preparedness coordination in cities and jurisdictions around the county responded with the results summarized in the following Table 7.

Table 7. Local Jurisdiction and Regional Agencies with Authority/Responsibility for Medical Response Coordination.

Local Jurisdiction and Regional Agencies with Authority/Responsibility for Medical Response Coordination		
Response	Number	Percentage
Public Health	20	28.2%
EMS	17	23.9%
Fire	16	22.5%
Other	8	11.3%
No Agency Clearly Identified	7	9.9%
Don't Know	3	4.2%
Total Responses	70	

The results appear to demonstrate that the perceived or actual authorities cross a spectrum of different agencies depending on the jurisdiction. There is no consistent agency at the local level that has the authority, and over 10% of the respondents either did not know, or had no agency clearly identified with that responsibility.

E. CURRENT MEANS OF COORDINATION

There is little, if any, published information that adequately describes just how medical system coordination occurs at the local level around the nation. The survey was an attempt to ascertain at least enough actual information from enough jurisdictions to get a semblance of how medical coordination occurs around the country. A series of survey questions posed to the 124 MMRS jurisdictions was designed to gather data on just how many different ways coordination took place in the major metropolitan areas. The number of responses varies depending on the questions asked and the applicability of the question to the respondent's jurisdiction. Because the concept of a dedicated MOC is relatively new, there may also be some degree of confusion with the terms presented in the questions, and there may be some inconsistency between questions. Still, the data collected proved useful to demonstrate the multitude of ways in which the medical system is coordinated during a response.

The first substantive survey question asked simply where the coordination took place:

Table 8. Local Medical Response Element Coordination.

How is the coordination of the local and medical response elements (focused on individual care i.e., EMS, hospitals, and long-term care facilities) coordinated?		
Coordination Location	**Percentage**	**No.**
Don't Know-Not Sure	1.6%	1
Not Coordinated	0.0%	0
Coordinated solely the ICS in the field	4.9%	3
Generally identified seats in an EOC	31.1%	19
Specifically identified medical operations center seats in an EOC	9.8%	6
Specifically identified public health operations centers seats in an EOC	1.6%	1
Specifically identified combined public health/medical operations center seats in an EOC	16.4%	10
Separate and distinctly identified medical operations enter seats in an EOC	1.6%	1
Separate and distinctly identified public health operations center co-located with EOC	0.0%	0
Separate and distinctly identified combined medical and public health operations center collocated with EOC	9.8%	6
Separate and distinctly identified medical operations center located	6.6%	4

away from EOC		
Separate and distinctly indentified public health operations center located away from EOC	1.6%	1
Separate and distinctly identified combined medical and public health operations center located away from EOC	9.8%	6
Other Locations:	4.9%	3
Total Number of Respondents:		**61**

More than 70% of the jurisdictions stated that the coordination took place in the local EOC. Three jurisdictions (5%) coordinate the medical system from out in the field. Less than half of the jurisdictions (44%) utilizing an EOC identified those seats as "general." The remaining number of jurisdictions coordinating in an EOC answered with variations of separate and distinctly identified seats.

The possible confusion over the term "general seats" becomes apparent with the results of the next two questions. When asked about the number of general seats used, more than the original 44% responded (Table 9).

Table 9. Number of Medical System Seats in Local EOC.

If the medical system response is coordinated through general ESF-8 seats in an EOC, how many seats are dedicated to personnel tasked with that mission?		
Answer Options	**No. of Jurisdictions**	**Percentage**
Doesn't apply to my jurisdiction	18	30.5%
0	1	1.7%
1	7	11.9%
2-4	25	42.4%
5-7	3	5.1%
Over 7	5	8.5%
Total Responses		**59**

Once again, when asked whether they felt the number of general seats was adequate, the number of responses exceeded the initial 44. This could be the result of confusion about the term general or misreading the question and answering based upon the number of seats regardless of their identification.

Although inconsistent, the responses to the three questions provide some useful information about medical system coordination. Regardless of the nomenclature attached to the seats, over 80% of the jurisdictions using an EOC to coordinate a medical response have four or fewer seats dedicated to that purpose.

The results still can give an idea of the perception of adequacy for the current means of coordinating a medical response. Of those responding, 40% felt that the current means would be adequate for all incidents. The remaining 60% felt that current means would work for a small to moderate incident, but not for a large incident (50%) or would not work for most, if any incidents (7.5%). One respondent felt that the current system in his or her jurisdiction was not adequate for any incident.

Table 10. Respondent Opinion on Adequacy of Number of EOC Seats.

If the medical system response is coordinated though general ESF-8 seats in an EOC, do you feel that the number of dedicated seats is adequate to coordinate the medical system response during a natural disaster, act of terrorism, or public health emergency that either compromises the medical system or creates a large number of injured/ill?		
Response Option	**Number of Jurisdictions**	**Percentage**
Doesn't apply to my jurisdiction	21	34.4%
Yes, for small/moderate incidents, no for larger incidents	20	32.8%
Yes for all incidents	16	26.2%
No for most, if not all, incidents	3	4.9%
No for all incidents	1	1.6%
Total Response		**61**

For the jurisdictions that had adopted some means of a separate off-site medical-system coordinating mechanism, I wanted to find out which agency or organization was the primary operator of the center and where the center was physically located to see if there were any consistencies with the spontaneous development of the relatively new modified means of coordination. Both questions were asked on the survey. The results of the thirty-six agencies that responded to the question about the lead agency clearly show

that medical system operations centers are located in a wide array of different agencies. As may be expected, the locations of the different operations centers were also spread out among numerous organizations and agencies.

Table 11. Primary Agency Operating Separate Medical Operations Center.

If your MMRS jurisdiction utilizes a separate medical systems operations center to coordinate the medical system, which agency or organization is the primary operator of the center?		
Response Options	**Number of Jurisdictions**	**Percentage**
Does not apply to my jurisdiction	26	41.9%
Emergency management Agency	3	4.8%
EMS Agency	6	9.7%
Local Public Health Agency	7	11.3%
Fire Department	3	4.8%
Local Homeland Security Agency	0	0.0%
Hospital Association or Council	2	3.2%
Individual Hospital	1	1.6%
Trauma or Medical Coordination Group	4	6.5%
Medical Consortioum/501C3	1	1.6%
State Health department	4	6.5%
Other	5	8.1%
Total Responses		**62**

Table 12. Location of Medical Operations Center If Away from an EOC.

If your jurisdiction's local/regional disaster medical system coordinating center is located away from an EOC, where is it located?		
Respondent Options	**No. of Jurisdictions**	**Percentage**
Doesn't apply to my jurisdiction	34	57.6%
Public Health Agency	11	18.6%
Hospital(s)	1	1.7%
Separate Trauma/Medical Coordinating Center	1	1.7%
Public Safety Dispatch Center	0	0.0%
Public Safety Agency	2	3.4%
Professional Association	0	0.0%
Other:	10	16.9%
Collocated with Public Health Operations Center	(1)	
Regional Coordinating Hospital	(1)	
Seat located in EOC or collocated in EOC	(3)	

Stand alone facility	(1)	
On EMS property or within EMS agency	(3)	
Still in development stages—no location yet	(1)	
Total Responses		**59**

F. ANALYSIS

The good news is that even after all the information presented in this chapter, most Americans have access to some of the finest medical care in the world. This high level of care may be part of the problem; it is unknown how much longer the United States can afford to sustain the costs of such care, and there seems to be an ever-increasing number of individuals that can no longer afford the health insurance needed to pay for care. Consequently, cost containment efforts are affecting surge capabilities, and the uninsured are seeking more care for less acute illness and injury at the default provider—the emergency department. These factors, combined with the potential future demands placed on the system by an aging population are creating increasing daily stressors on the medical system, which does not bode well for the medical system's capability to respond to a future mass-casualty incident or catastrophic event.

The sheer number of public agencies, organizations, businesses, non-governmental agencies, and health-care providers that constitute the medical system is so vast that coordination of the activities will be a challenge in the best of circumstances. It is significant that employees who work in the system struggled to name all the components of the system in the focus groups. One group gave up after a short while acknowledging that the task was impossible—some unknown element would surely be left off the list.

The system elements provided by the groups also included many non-medical agencies—descriptive of the reach, depth, and interdependency of the medical system with its response partners. The medical system appears as a many-armed hydra with its tentacles intricately interlaced with other health-care providers and outside agencies. The system defies description beyond the functionality of providing individual medical care. As anyone who has tried to work his way through the system as a patient will tell you, access to resources and care can be multifaceted and at times bewildering. Yet it is this

system, during a mass-casualty incident, that we depend upon to maximize its resources to save our lives, bind our wounds, and return us back to a post-incident world as whole as possible.

The discussion demonstrated both the scope and complexity of the some of the better-known elements of the medical system. The flagships of the system, the large acute care hospitals, often represent a small and privatized microcosm of the community surrounding them. Each facility not only offers medical care, but also transportation, fast food, coffee shops, art, and shopping. Some facilities even have hotels built into their structures. One of these often is large enough to present significant coordination challenges, yet the majority of metropolitan areas have numerous facilities both large and small as either a non-specific acute-care facility, or a provider of highly focused and specialized care.

The EMS system in the country is highly fragmented and found in multiple organizational structures, both public and private. Long-term care facilities, taking care of our most vulnerable population, will continue to grow in both number of beds needed and specialized services offered. The physician community and other components of the health-care system will likely remain an increasing large and complex group of niche service providers that will constantly evolve in reaction to regulations, technological advances, and market forces. Based on sheer number and complexity, the system needs an effective coordinating mechanism that understands the system and can escalate to meet response needs during a large mass-casualty incident or catastrophic event.

Several factors prevent the medical system network from spontaneously adapting to a mass casualty without some sort of coordination. These factors include the imperfect nature of the network, time, and community expectations. The medical system is actually a network of networks that integrate both vertically and horizontally. Between each network, there is a potential delay or stopping point as one network has its needs met and has no stake in making sure that the rest of the network changes. Even though all of the network would eventually adapt to the significant change in the external environment, that adaptation would occur much too slowly and result in needless loss of life.

The community expects its government, at all levels, to take active steps to mitigate any disaster. The government has responded by instituting command, control,

and coordination mechanisms such as emergency operations centers and the Incident Command System. The community also expects effective and active coordination of the medical system.

The challenges faced by the medical system are real and far-reaching. They create a current environment where the medical system may not be able to live up to the expectations of the community or even of those responsible for overseeing a response. A disaster is not the time to discover these challenges. The challenges need to be acknowledged and mitigated both before an incident through planning and during an incident through an effective coordination of resources and information.

The authority and responsibility for coordination of the medical system response is an important first step in determining the agency that should be doing the coordination and the effectiveness of the current methods. It is not surprising that most of the authorities are found in EMS and public health since those are the predominate agencies given ESF-8 responsibility in local emergency operation plans. The relatively high percentage of fire departments having the authority may be a reflection of the relatively large number of fire departments administering the MMRS program (the survey respondent source) or the respondent's assumption that coordination takes place in the field, where fire departments usually are the lead agency. Unfortunately, the survey did not drill down to identify the "other" category, which may have added additional players. The large number of unknown or no agency clearly identified (14%), if extrapolated to a national level, would show an alarming number of jurisdictions who either have not addressed the issue, or are dependent on state agencies to provide the coordination.

The assessment of the current means of coordination was partially successful at best. Most of the medical system coordination is still done through seats in an emergency operations center (EOC) with four or fewer positions to manage the medical system during an incident. A number of jurisdictions have taken the step of moving the medical system coordination out of the EOC and into another entity.

A significant statistic is the fact that 60% of the jurisdictions that still use a small number of seats in an EOC do not feel that their current means of coordination would be

adequate for a large mass casualty or catastrophic event. Just as significant is the fact that 40% do feel that their current means would be adequate. This could be a reflection of a number of factors: an extraordinarily efficient and capable process of coordination, the small number of entities coordinated, coordination resources present in the field through ICS, or the fact that the jurisdiction has not experienced an incident requiring the management of a large number of casualties.

In summary, the current medical system is extensive, varied, and coordinated through a myriad of different means and agencies (or not at all). The system faces some significant current and future challenges. With little prospect for significant improvement of those challenges in the near future, it is imperative that the medical system resources available during a disaster are managed with the higher efficiency and effectiveness that a medical system coordinating center would offer. In the next section, I will discuss four jurisdictions that recognized this fact and took steps to ensure effective medical-system management during a mass-casualty incident.

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III. COLLABORATION AND THE MEDICAL/PUBLIC-HEALTH SYSTEM NEXUS

Two areas need further study to determine the success of a medical operations center and the environment in which it will operate. Any entity whose main purpose is to coordinate and communicate will need cooperation and collaboration from the various agencies involved. This holds especially true with any coordination of the medical system's varied components. The collaboration can be forced or obtained willingly—but it has to occur.

The differences between the medical and public-health systems, alluded to in earlier parts of the thesis, play an important part in defining any coordination entity. The local, regional, or state jurisdictions establishing a mechanism for medical system coordination need to be acutely aware of any differences or similarities between the two systems.

In this section, each of these two areas and its relationship to medical-system coordination will be discussed. Specific questions about collaboration and the medical and public-health systems were asked of the focus groups and survey respondents. The answers to those questions will be incorporated into the discussion.

A. COLLABORATION

Willingness and ability to collaborate are crucial to any type of coordination effort. This is particularly true when trying to collaborate among the scores of disparate agencies, communities, and organizations that are outlined in the previous section. There must be a perceived need and a perceived value for all parties concerned. Even then, other variables must fall into place. Maldin et al. performed a set of qualitative interviews among thirteen different states and regions on the subject of group preparedness coordination. From this study the authors arrived at several key steps that enhanced the coordination efforts of the hospital groups. Some of these key steps are identified below.[64]

[64] Maldin et al., "Regional Approaches to Hospital Preparedness," 43–53.

- Creation of planning bodies;
- Defining the regions;
- Defining the gaps;
- Support and leadership of hospital executives;
- Neutral entity to bring together organizations that are historically competitors;
- Engagement of trade associations and organizations.

Since the medical operations centers must accomplish successful collaboration, each one of the focus groups provided input on what they perceived to be some of the positive variables that led to their successful collaboration. The focus groups also relayed what negative collaboration variables arose during the MOC development process. In the survey, the MMRS jurisdictions ranked a selected list of potentially positive collaboration variables and potential barriers. The survey allowed participants to provide their own potential barriers.

The Houston focus group identified numerous activities that had led to positive collaboration. These included the effects of tropical storm Allison, the MMRS program, and unwavering support from Houston Emergency Management. The group also added persistence and a focus on positive outcomes, an atmosphere of trust, open communications, mutual respect, reaching consensus, actively seeking input, as positive activities. The process centered around a practical, lean, and functional regional plan, capturing and documenting all ideas, tracking and displaying progress to demonstrate forward movement, sharing best practices, visibility, and a shared workload. The lack of a scripted formula provided poetic license to create what they felt they needed.

Positive collaboration factors provided by the San Antonio focus group included matching preparedness regions with medical system and catchment regions, a charismatic leader, suspending egos, and the preexisting credibility of the coordinating agency (STRAC). Other factors responsible for the program's early successes included positive preexisting relationships, a perception of value, and understanding and accepting various personalities. The availability of preparedness funding also helped by getting people to

the table to start the collaboration process. The group also added that hurricane Katrina helped because it was the first activation; everyone worked together to solve problems, built trust to "air out dirty laundry," and helped break down parochialism.

Oklahoma City felt that the city's shared experience with numerous disasters was an important background item that helped facilitate collaboration. Other factors mentioned included hardware and software provided to facilitate collaboration, significant support from hospital executives, demonstrating how competition disappears during a disaster, and a realization that it takes a total group effort to get through a disaster. The Oklahoma City medical community also perceived value from an MOC and expressed the desire for consistent and uniform processes, a shared vision of doing the greatest good, and a way for smaller hospitals to contribute.

The Houston focus group felt that the negative collaboration variables were far fewer, but listed competition in health care, egos, and turf, mandates being counterproductive, the need to find common ground, and the lack of an existing model or plan to use as a template.

San Antonio had more challenges to collaboration. The first challenge involved the general situation in Texas, a home-rule state with multiple parochial small jurisdictions grouped into different regions that share no commonality. There are regions for trauma and councils of government that do not coincide. Their catchment area forced them to work with multiple people from one discipline because multiple regions touched their catchment area. Other challenges included a lack of understanding of emergency management principles by public-health personnel, a lack of understanding of ESF-8 by emergency managers, a lack of depth in both understanding and the number of people who understand the challenges of a medical system response, and no "ringmaster" for the medical system. San Antonio also had to contact and convince someone from each sector of the value of the medical operations center, endure the parochial nature of cities whose leaders had to be convinced that events occurring outside city limits could eventually affect those inside city limits, and counter the perception that the MOC was adding another layer of bureaucracy.

Oklahoma City experienced the perception that all things are cured by technology, a persistent low-level competition among facilities, and facilities that maintained a position against sharing information. This group also discussed the lack of time and personnel to work the development, personal agendas that undermined group success, and a near-constant competition from other crisis priorities within the organization.

The survey results also provided some interesting data that supports the information provided by the focus groups. The survey included a list of collaborative factors. The survey respondents ranked each factor from most important to least important. As Table 13 shows, the most important factors to support collaboration were a clear mission and purpose, perceived value by the participants, buy-in from executive level management, and clear lines of authority and responsibility.

Many of the respondents used the opportunity to provide other collaborative factors not listed on the table. Some of the factors provided included:

- "Integration (with the local jurisdiction) of the regional and state personnel and assets which reside in the local jurisdictional area."
- "What has worked very successfully in our area is the ability of agencies across disciplines to see beyond their traditional roles. We do not have as many "silos" to overcome as in some parts of the nation. Law enforcement (for example) plays an active role in many public health meetings without complaint. Just as public health plays a role in Hazmat."
- "Collaboration within the medical and emergency management community is important. Sheltering is a good example. Our MOC handles medical mass care operations, which includes medically fragile shelters. The Office of Emergency Services is charged with all general population shelters. Lines of responsibility have been drawn very carefully."
- "Tri state issues dealing with three state capitals as opposed to just one bureaucratic authority."

- "This section is rather confusing since for this area we would consider most of these as being very important and that they would have definite impact on the collaborative effort."
- "MMRS and HRSA goals should be coordinated with CERT and MRC. Get the most medical response for a community by pushing for a higher payoff (major response) goals as a team approach versus each grant trying to purchase/train on non-supporting task."

In a similar process, the survey respondents also ranked a list of potential barriers for establishing a medical operations center. Table 14 shows the results of that ranking. The most significant barrier was the lack of available funding to develop a coordinating entity. Other significant barriers included competing city priorities, lack of authority, and lack of a clear oversight agency. Interestingly, respondents did not feel that cooperation and collaboration would present much of a barrier.

The survey respondents also identified other potential barriers not included in the list. Some responses described the situation in the respondent's particular jurisdiction, while others offered the clear potential barriers and thoughts listed below.

- "The people who would operate within the EOC are the same people who generally run the HOC at each hospital and the administration will not let them leave. We have been trying to do this and have not been successful."
- "Lack of legal authority to execute actions."
- "The MOC would either interfere with, or add another layer to, the process for requesting resources."
- "Flexibility for the local jurisdiction to determine how coordinated healthcare response should be conducted while meeting state and federal initiatives."
- "Grant Silos—multiple grant flows with the same edicts, but agencies do not want to coordinate the functions due to the possibility of losing their part of the funding. We need one grant that is for all."
- "A commitment of integration of resources and assets. Most agencies know "integration talk" but are more concerned about their budgets and turf."

- “Regionalization is a good idea in theory and on paper … but the rules as they now are definitely set in opposition from everything to governance to coordination to operational.”
- “Jurisdictional boundaries of the medical system cross many other jurisdictions with separate emergency management centers. There may be some issues/resources that are competitive.”
- “Sustainability, training, available personnel to utilize during an operation.”
- “All medical operations should be conducted under the EOC as other agencies will most likely be affected as well. Should be co-located in one EOC.”

Table 13. Ranked Impact of Positive Collaboration Factors.

Please rank the impact of the following potential factors on positive collaboration and cooperation on a scale of 1-12 with 1 being the most important and 12 being the least important.														
Response Option	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**Response Count**	**Response Average**
Clear purpose and mission	10	8	5	7	3	4	4	1	2	1	1	1	46	4.24
Value perceived by participating organizations	4	1	12	9	5	1	1	5	1	1	1	0	41	4.54
Buy-in from local jurisdictions	6	7	5	2	6	7	2	3	2	0	0	3	43	4.81
Clear lines of authority and responsibility	1	9	5	2	11	4	3	7	2	0	0	0	44	4.91
Buy-in from executive leadership in organizations	8	3	4	6	5	5	5	2	2	2	0	2	44	4.95
Availability of funding to accomplish tasks	8	6	1	5	4	5	1	4	3	3	2	1	43	5.19
Regulation by state and local authorities	5	3	7	5	0	3	4	6	6	6	3	1	49	6.22
Participation tied to accreditation requirements	2	4	2	4	2	4	6	3	5	4	9	0	45	7.02
Presence of a qualified “champion (s)” to move process	1	2	1	3	5	5	6	1	5	7	4	4	44	7.55
Effective communication of needs and progress	1	2	1	2	3	3	7	4	5	6	7	2	44	7.84
Participation tied to Medicare reimbursement	3	2	2	3	2	4	3	2	2	5	3	17	48	8.35
Effective meeting and time management	0	0	0	0	0	3	2	5	7	6	10	11	44	9.93

Table 14. Rating Impact of Barriers to Establishment of MOC.

Please rate the impact of the following potential barriers for establishing a medical operations center should one be desired.									
Response Option	**5 High**	**4**	**3**	**2**	**1**	**0 Low**	**N/A**	**Response Count**	**Rating Average**
Lack of available funding	31	8	7	1	0	2	6	55	4.29
Competing city/regional priorities	12	15	8	4	3	3	9	54	3.44
Lack of statutory or ordinance authorities	12	12	7	8	3	3	10	55	3.29
Lack of a clear agency/organization to oversee center activities	9	15	7	5	3	5	11	55	3.16
Perception of duplication by emergency management agencies	10	12	10	5	2	8	8	55	2.98
No perception of actual need by the medical community	7	12	11	8	3	6	8	55	2.87
Perception of duplication by public health agencies	5	13	13	9	0	7	8	55	2.85
Lack of available space	9	8	11	5	7	6	8	54	2.76
Competition of medical system organizations	4	14	7	10	4	6	10	55	2.69
Perception of duplication by public safety agencies	5	8	12	10	3	8	9	55	2.52
Lack of collaboration from medical system organizations	5	5	13	9	8	5	9	54	2.44
Involvement of for-profit organizations into mechanism	3	10	10	5	10	6	10	54	2.39
Lack of jurisdictional cooperation	6	5	9	8	8	7	9	52	2.35
Availability of technology	3	4	9	9	9	12	8	54	1.85
Rating Average: Responses yielding a positive number compiled and divided by the number of respondents providing a score. Responses of N/A were not included in the equation									

B. THE MEDICAL AND PUBLIC-HEALTH SYSTEM NEXUS

Earlier in the thesis, I made the case that the medical system and the public-health system were two distinct disciplines that have a long history of separate development and a different focus and methodology; at times they have been opposed to one another. Despite these differences, the two must end up working in concert to prevent, respond to, and recover from the health consequences of a mass casualty or public-health emergency. While the two systems are separate and different, they are both critically important and not mutually exclusive.

Although the differences between these two systems do not necessarily affect the determination of whether a medical-system coordination entity needs to be created, the differences do play a significant role in how such entities are formed and the type of activities that would be conducted by an MOC. The relationship between the medical system and public-health system could prove consequential in both the short-term operational success and the long-term survival of an MOC. I included the subject of the differences between the two in both my focus groups and the survey in order to determine whether the relationship and operational differences matched those found in the literature.

I asked the focus groups how they thought the two systems were the same or different and their opinions on what those differences or similarities were. I also asked the groups about their opinion on splitting ESF-8 into two distinct emergency support functions—a rather radical step—to help determine how strongly they felt about the differences.

Both the Houston and San Antonio groups felt that the public-health and medical systems were two distinctly different systems. The Oklahoma City focus group felt that each system was the component of the other and, while different, were strongly linked. When asked about similarities, the San Antonio group had little to offer. The Oklahoma City group pointed out that public health at times does direct patient care as in the isolation and care of TB patients.

The Houston group said that there were similarities and that the two were absolutely connected. A “cycle of care” includes prevention, acute treatment, and activities to reduce a recurrence. The public-health and the medical systems both have key roles in that cycle and each one’s activities has a direct effect on the other’s activities.

When asked about the difference, the majority of comments tended to address the different areas of focus. The Houston group said that the community and general-population focus of public health was markedly different from the individual-based focus of the medical system. Oklahoma City echoed that opinion. The San Antonio group said that there was a difference in both the focus and the approach. The medical-system

entities often have to act immediately with action based upon incomplete information, while public health waits until complete information is available. The consequences of a wrong decision, when applied to a community intervention, can have catastrophic consequences—hence the tendency to wait for as much information as possible.

Public health tends to face long-term corrective situations while medicine tends to be quick, fix it, and move on. While the public-health approach exists for a very good reason, during an emergency it may be difficult for public-health trained leadership to react quickly and make decisions. The San Antonio group felt that public-health physicians who tend to do well in emergencies are those with emergency-department backgrounds, which allows them to switch over to an immediate, partial-information, decision process.

The survey asked similar questions of the MMRS jurisdiction respondents. The first question asks about the difference between the public-health system and the medical system. Table 15 shows that a large portion of the survey respondents felt that there was a significant difference between the two systems.

Table 15. Is There a Distinct Difference between the Medical System and the Public-Health System?

HSPD-21 differentiates between the medical system (healthcare activities geared towards to the individual) and the public health system (healthcare activities geared to populations). Do you feel that there is a distinct difference between the medical system and the public health system?		
Response Option	**Response Count**	**Response Frequency**
Don't know/no opinion	5	9.1%
Yes, there is a difference	42	76.4%
No, they are the same thing	8	14.5%
Total Responses	**55**	

The next question attempted to determine the strength of the answer to the previous question. The results scored between "moderately strong" and "strongly."

Table 16. Strength of Opinion That Systems Are Different.

How strongly do you feel about the following? Note: "Don't know/no opinion" answers were not part of the rating average.								
Response Options	**4***	**3**	**2**	**1**	**0**	**Don't Know/No Opinion**	**Response Count**	**Rating Average**
How strongly to you feel they are different systems?	14	17	10	4	6	5	56	2.57

*4=Very Strongly; 3=Strongly; 2=Moderately Strongly; 1=Somewhat Strongly; 0=Feel they are the same

In order to double-check the previous response, and to view the opinion from a different angle, I asked how strongly the respondents felt that the two were the same. Table 17 shows that over 65% of the respondents once again felt that the medical and public-health systems were indeed different.

Table 17. Strength of Opinion That Systems Are the Same.

How strongly do you feel about the following? Note: "Don't know/no opinion" answers were not factored into the rating average.								
Response Options	**4***	**3**	**2**	**1**	**0**	**Don't Know/No Opinion**	**Response Count**	**Rating Average**
How strongly to you feel they are the same system?	5	1	2	6	36	5	55	0.66

*4=Very Strongly; 3=Strongly; 2=Moderately Strongly; 1=Somewhat Strongly; 0=Feel they are separate systems

The survey's next question attempted to determine what the respondents felt the relationship should be between a medical operations center and any public-health operations center that might be in existence. Given that the opinion of both the focus groups and the survey respondents held strongly that the medical system and the public-health system were different, perhaps the coordinating entities should be different as well.

Surprisingly, the answer shown in Table 18 shows that a significant number (68.5%) of the respondents felt that both entities should be together under public health in order to have consistency in managing ESF-8 activities. There appears to be recognition of the linkage and inter-dependence of the two systems.

Table 18. Opinion on Separating an MOC from a Public-Health Operations Center.

Should a medical operations center (if one was created) be separate and distinct from a public health operations center (if one exists)?		
Response Options	**Response Count**	**Response Frequency**
Yes, they are distinctly different and coordinate markedly different activities	17	31.5%
No, they should be together under public health in order to have one point of contact for ESF-8	37	68.5%

The last area explored was the role that the two systems play in the medical and public-health emergency-support function (ESF-8) found in the National Response Framework and in most local and state emergency operations plans. ESF-8 serves as an umbrella functional area and contains both medical and public-health response activities. One agency must be designated the "lead" agency. This lead agency assignment at the federal and state level is not a problem—health agencies regulate both medical and health activities. It becomes more of a challenge at the local level where separate agencies may perform the lead role for each of the systems. If there is such a distinct difference, perhaps ESF-8 should separate into two or more unique functional areas.

I asked the focus groups whether ESF-8 should separate into distinct functional areas. Even group members who vehemently pointed out how the two systems were different did not feel that ESF-8 should separate because "it's all health care." Some

groups felt that a distinction should be made within ESF-8 between a medical-system responsibility and a public-health system responsibility. Other group members suggested an ESF-8A and an ESF-8B.

The survey asked a similar question:

Table 19. Opinion on Separation of ESF-8.

Do you feel ESF-8 should be separated into two distinct emergency support functions?		
Response Options	**Response Count**	**Response Frequency**
Don't know/No opinion.	8	14.3%
There needs to be a separate ESF for medical system response and another ESF for public health system response.	10	17.9%
ESF-8 needs to maintain the current medical/public health overall function, but there needs to be a clear separation between the two systems and their activities within the ESF.	18	32.1%
ESF-8 is fine how it currently exists. Although there may be a difference in systems, the overall goal is health care.	16	28.6%
ESF-8 is fine how it currently exists. There is no difference between the two systems.	4	7.1%

Table 19 shows that the majority of the survey participants who offered an opinion (79%, n=38) did not support changing or separating ESF-8 into separate medical-system and public-health-system functions. A majority of those who offered an opinion did say that there needs to be a clear separation between the functions of the two systems, either though separating the two (20%, n=10) or by making changes within the current ESF-8 (37.5%, n=18).

C. ANALYSIS

Collaboration among the various medical-system components is crucial for a successful MOC. I found the comment by the Houston focus group that "mandates don't act as a facilitator" to be both profound and true. True collaboration really depends on a

voluntary willingness to interact in a positive way. The best way to make this happen is to provide a perception of, or real, value for both parties so that the collaboration continues growing in a win-win situation.

Another powerful mechanism for collaboration is a community's first-hand experience of a disaster, when it realizes the need for an effective means of coordinating the medical system. Since we really do not want to rely on that sole facilitator, we must look for some of the other positive collaboration factors experienced by the focus groups and echoed by the survey participants. These factors include regionalization that matches the natural catchment region of the medical system; a neutral and charismatic leader; the establishment of consensus, no matter how painful; and a focus on positive outcomes and small victories. Additional collaboration facilitators include support from emergency management; public-health involvement; support from the executive level in the agencies and organizations that compose the medical system; availability of funding; and a shared vision of the challenge and the solution. It is also noteworthy that the collaboration factors outlined by the focus groups and survey participants were also remarkably similar to the variables for successful regionalization offered by Malden et al.[65]

Barriers are inevitable when embarking on any new enterprise. It is important to recognize and inventory those barriers to determine first if the desired action is possible. If it proves to be possible, then the barriers need to be eliminated or at least mitigated. The survey participants, for the most part, were expressing perceived barriers, while the focus groups were presenting actual barriers experienced during the development of the MOC. Perceived barriers may turn out not to be barriers at all, while unanticipated problems can suddenly surface and present a challenge. Some issues, such as the lack of an established template for an MOC, can be either a barrier or an opportunity, depending on the approach.

While the focus groups identified a few barriers, such as jurisdictional make-up, competition, competing priorities, and lack of understanding by emergency management and public health, the number of barriers seemed relatively low. The survey participants

[65] Maldin et al., "Regional Approaches to Hospital Preparedness," 43–53.

seemed to focus on the availability of funding. The reality is that funding is currently available from numerous grant sources. Even without the immediate availability of grant funding, the cost of establishing the rudimentary ability to coordinate the medical system is very low when compared to the potential gain. The $40,000 start-up cost of the Oklahoma City MERC is less than the cost of a single EMS command vehicle.

The medical and public-health systems are two separate disciplines, but they are intertwined and interdependent. Through a long historical development process, the two systems emerged in silos with many differences in both focus and approach. More recently these silos were exacerbated by the emergency-preparedness grant mechanisms. Unlike the pre-9/11 MMRS program, which focused on locally administered and joint medical and public-health system development, the state-administered CDC and HRSA (now ASPR) grants were state administered and focused on a specific system. Unless a jurisdiction was as fortunate as San Diego and Boston to have both medical and public health under one agency, this meant that separate agencies received separate funding to do separate activities. The silos hardened.

The focus-group discussions and survey results on this issue were enlightening. The Houston and San Antonio focus groups quickly and universally agreed that the two systems were markedly different. Oklahoma City preferred to state that each was a component of the other—another way of stating that they were interdependent. Although the groups were quick to point out the differences, they were hesitant to agree that ESF-8 should be split and instead offered an option of ESF-8A and ESF-8B, another way of stating the overall shared and interdependent mission of both systems in providing health care. The survey respondents also felt strongly that the two systems were markedly different. Like the focus groups, and despite the agreement that the two are different systems, the survey respondents did not feel that ESF-8 should be split. A significant percentage (37.5%) also felt that both should be under ESF-8 but clearly delineated to mark the difference between the two systems.

Most telling, however, was the response to whether or not the medical operations center should be operated outside of the public-health system. A large majority of the survey respondents felt that it should be put under public health to ensure one point of

contact for ESF-8, a clear indication that separation between the two systems is not desired. Other factors, including public health's expertise and legal authorities and exceptions, also argue for the continuation of a connection between the two.

Public health is relatively new to the concepts of immediate disaster response. The grant programs and their accompanying work requirements have helped to further the idea of separation. However, public health is learning. As one focus group member put it, "I would hate to exclude them; we have worked so hard to teach each other and have learned so much, I'm afraid that separation would be a step backwards."

In summary, the research has reinforced the fact that the two systems are different. It has also identified the need for some type of enhanced mechanism, such as a medical operations center, to effectively coordinate the myriad of challenges faced by the jurisdiction's medical system during a disaster. Although the two systems are different, there is no need to separate ESF-8 into two different support functions. The differences between the two need to be clearly identified and recognized.

Lastly, even though the medical system and public health are different, a medical operations center should not operate independently of the public-health system and would be better served working as part of the public-health system. The only remaining question is how to take this information and build something that serves both the local jurisdiction in particular and the nation as a whole. We can start by examining four medical operations centers currently serving the needs of their local communities.

IV. EXAMINATION OF CURRENT MEDICAL OPERATIONS CENTERS

While many jurisdictions still utilize a small number of individuals in an EOC to coordinate particular sections of the medical system, other jurisdictions have already established a distinct medical operations center in order to coordinate the complex needs of the medical system during an emergency. These jurisdictions understand, or have experienced, some of the medical-system response challenges presented earlier. They realize the differences and similarities between the medical and public-health systems. They have already embarked upon the collaborative process and confronted some of the development challenges, instituting a relatively new concept in response coordination.

To help describe the concept of an MOC, I will present four of these jurisdictions and discuss the journey of their development. Each jurisdiction developed its MOC independently, yet there are many similarities in both experience and final product. Included in the discussion are the origins, structure, and function of each MOC. Each jurisdiction has adopted a different name for its respective center, but the functionality is the same.

Some of the centers presented have actually operated the MOC during an actual mass-casualty incident or public-health emergency. The lessons learned during these real activations will help establish the need, function, and applicability of the medical operations center concept.

A. OKLAHOMA CITY[66]

Name: Oklahoma City Medical Emergency Response Center (MERC).

Main Sponsoring Agencies: The Emergency Medical Service Authority (EMSA) and the Greater Oklahoma City Hospital Council (GOCHC).

[66] The material in this discussion and that of Tulsa, except where otherwise noted, comes from the author's notes and experiences as the director of the Metropolitan Medical Response Systems in Oklahoma City and Tulsa and his participation in the development of the Medical Emergency Response Center in those two cities.

Established: 1999.

The Oklahoma City MERC did not originate after the Murrah bombing in 1995. After that incident many of the hospitals and EMS agencies agreed that there needed to be greater coordination and information flow, but any changes that occurred were internal. After the May 3, 1999, tornado that left 45 dead and over 800 injured, the hospital and EMS agencies realized that they were in the same room talking about the same issues that had occurred several years earlier, and they decided to act. The Metropolitan Medical Response System (MMRS) contract between the U.S. Department of Health and Human Services (USDHHS) and Oklahoma City began shortly thereafter and provided some of the initial funding for the center.

The MERC was initially located in the training room at EMSA Headquarters. EMSA wired the room for internet connection, 25 phone lines, two radios, and a duplicate CAD console. Cabinets stored the equipment for deployment upon need. EMSA administrative staff in the building, supplemented by on-call hospital personnel, operated the center on activation.

This dual use of space was cost effective but provided some challenges to equipment security and training schedules. When Oklahoma City remodeled its old 911 center into a regional EOC, a dedicated and permanent space was provided for the MERC.

The current MERC has the capability of housing up to 20 positions. Each position has a dedicated phone and laptop. The MERC has two duplicate EMS computer-aided dispatch consoles that allow the capability to communicate with EMS transport officers in the field. There are multiple electronic visual display boards and a specific area designated for HAM radio communications.

The Oklahoma City MERC is an on-call coordination center. It is not staffed unless there is a perceived or actual need for medical-system coordination. One FTE from EMSA is dedicated to the MERC to provide training, coordinate drills, maintain the on-call schedule, and ensure that the equipment is in operating order. The remainder of the staffing comes from personnel designated from the local participating agencies. Four

personnel are on call each month. If the MERC activates, these individuals report to the MERC along with EMS and public-health personnel, begin the coordination process, and assess the situation to determine the need for additional staffing. If additional staffing is needed, the hospital system sends a representative from each of its facilities.

Figure 1. The Oklahoma City MERC during an exercise. (Photo by Mike Curtis, used with permission.)

The MERC provides space for numerous agencies including the hospital system, EMS, public health, and the American Red Cross. Being located with the regional EOC also provides instant access to public-safety and utility representatives. The MERC provides coordination for forty-two hospitals, eight EMS agencies, seven public-health departments, and a host of other medical-system components.

The Oklahoma City MERC acts as the ESF-8 coordinating body for the Oklahoma City metropolitan area and works closely with the Oklahoma City/County Health Department (OCCHD). OCCHD has established its own internal area within its agency to help coordinate its activities should it have to stand up multiple-medication distribution or mass-vaccination sites. This was done not only because OCCHD wanted to coordinate from its own building, but also because the space available for the MERC was deemed too small to coordinate all the activities associated with the possibility of multiple mass-immunization sites operating at the same time that the hospital and EMS system were overloaded during a public-health emergency. OCCHD provides a

representative liaison on all MERC activations to provide public-health advice and to connect back to the OCCHD facility if both are operating simultaneously.

The public-health agencies in the remaining six counties manage their response through four areas commands—all coordinated out of the MERC. The Oklahoma City MERC is one of several regional MERCs in the state that coordinate response information flow and prioritizations with the state medical and public-health operations center located at the Oklahoma State Department of Health.

The Oklahoma City MERC activated during 9/11 to monitor hospital supply needs when all air traffic came to a stop. In 2003, the MERC activated on two successive nights for tornado strikes in Oklahoma City. The MERC helped coordinate medical-system needs when a severe ice storm created a two-week power outage in 2007. Most recently, the MERC coordinated patient distribution during hurricane Gustav when military aircraft brought hospital patients to the city from Louisiana. Oklahoma City also hosted eighteen hundred victims from Louisiana during Gustav, and the MERC helped coordinate the medical response to a large congregate shelter for the evacuees. Each of the MERC activations shared two common characteristics: the coordination was needed and appreciated, while each incident presented a totally different set of challenges for the medical system.

B. TULSA

Name: Tulsa Medical Emergency Response Center (MERC).

Main Sponsoring Agencies: The Emergency Medical Service Authority (EMSA) and the Tulsa Hospital Council (THC).

Established: 1999.

While Tulsa has been fortunate to miss the frequency and severity of the disasters experienced by Oklahoma City, the city was deeply affected by those disasters and has its own history of numerous significant floods. Consequently, Tulsa spends a significant amount of energy on preparedness efforts and has a well-established and functional joint city/county emergency-management agency. Tulsa was a willing partner to Oklahoma

City in 1999 when a joint MMRS development project was proposed. Part of that development was the establishment of a MERC in Tulsa to complement the one established in Oklahoma City. Both cities agreed to support each other's medical needs during a disaster involving mass casualties; the two MERCs constitute the mechanism to coordinate such support. The oversight, function, and mission are similar, but the structure of each MERC is different, reflecting the differences between the two cities.

The Tulsa MERC was initially located in a police briefing room at the Tulsa 911 center. Like Oklahoma City the dual-use room was the only available space, was initially cost-effective, but eventually ran into conflicts with scheduling. The Tulsa MERC relocated to its current location when the Tulsa Area Emergency Management Agency (TAEMA) allocated space in its EOC. The Tulsa MERC currently coordinates a smaller number of hospitals and EMS agencies, and the design of the room reflects that smaller number. There are seven hospitals, one EMS agency, and one health department. Each agency has been provided a lockable workstation in the MERC, complete with computer and phone. Each agency can bring along plans, documents, and references unique to its agency to keep in the workstation prepared for ready access during activations. Like Oklahoma City, the Tulsa MERC has multiple phone lines, computer terminals, radios, and a duplication of the EMS computer-aided dispatch station. There is also direct access to the main floor of the EOC and the public safety, private sector, and government representatives located there. The Tulsa City/County Health Department (TCCHD) has also developed its own internal coordinating center for large public-health responses. This room, located at its main headquarters building, acts as the back-up MERC should the primary MERC become unusable.

The ESF-8 responsibilities in Tulsa are split between EMSA and the TCCHD. The MERC acts as the primary coordination center for the medical system in Tulsa and coordinates public-health activities through the MERC-TCCHD liaison.

In December 2007, Tulsa experienced a severe ice storm that downed power lines and pulled electric meters away from houses. Consequently, the entire metropolitan Tulsa area was without power for up to two weeks, creating a full activation of the Tulsa MERC along with the Tulsa EOC. From initially coordinating the hospital status and

patient movement from a busy EMS system, the role of the MERC quickly transitioned to addressing the needs of power-dependent medical patients at home and nursing homes wishing to evacuate, providing medical support for several large shelter operations and power for one large dialysis center to handle the needs of the entire city population. The MERC also coordinated with TCCHD to recruit medical volunteers for the shelter operations.

Figure 2. The Tulsa MERC. (Photo by Johnnie Munn, used with permission)

Toward the end of the incident, the Tulsa MERC coordinated the medical support for "Operation Power Up," a massive effort by the city that combined medical, fire, and power company resources to go through neighborhoods, check the welfare of the residents, and replace power meters to restore electricity.

C. SAN ANTONIO[67]

Name: Regional Medical Operations Center (RMOC).

Main Sponsoring Agencies: Southwest Texas Regional Advisory Council on Trauma (STRAC).

[67] The material in this discussion, except where otherwise noted, comes from the author's focus group of San Antonio RMOC representatives on May 14, 2008, and an interview with Eric Epley, STRAC Director, conducted on October 2, 2008.

Established: after September 11, 2001.

The idea for a regional medical coordination center actually began in the 1990s during several exercises where participants noticed that the EOC had several representatives who could reach back to their respective agencies, but one person was expected to reach back to twenty hospitals. Attempts to form an MOC met with resistance, and the medical system instead focused on trauma systems development, although the need for some type of coordination capability remained in the background, and conceptual meetings still occurred.

The events of 9/11 created a situation where the military bases and the base hospitals that were such a critical component of the medical system went to threat-level Delta and effectively closed. This created the need to make rapid adjustments with the remaining accessible hospitals and once again demonstrated the need for medical system coordination during a disaster.

The subsequent planning process for terrorism, and the availability of funding, brought the issue up again. Active planning resumed with STRAC taking the lead because of its leadership and preexisting relationship with the hospitals.

The San Antonio RMOC was initially located at the STRAC offices. STRAC converted a large training/meeting room to dual-use capability. San Antonio provided dedicated space for the RMOC when the city built a new EOC. The RMOC has over 20 possible positions with tables grouped according to specific functionality: Command/Control/Admin, Hospitals, EMS, and Public Health, and Medical Special Needs. The RMOC is an on-demand center with staffing provided by STRAC personnel and representatives from hospitals, EMS, special needs agencies, and public health reporting during activation. The main duties of the RMOC are patient destination coordination, timely patient flow, resource coordination for the medical system, and addressing the medical special-needs patients during a disaster.

The first real test of the RMOC occurred during hurricanes Katrina and Rita. During two twenty-four-hour periods, the RMOC was activated and coordinated the interhospital transfer of 781 patients and “thousands of evacuees and special needs

patients."[68] A retrospective study determined that the RMOC, based upon the principles of cooperation and communication, allowed for a more rapid transfer of hospitalized and special-needs patients during a disaster/mass-casualty situation.[69]

Figure 3. The San Antonio RMOC during a hurricane exercise in May, 2008, showing the hospital coordination tables. (Photo by Mike Curtis, used with permission)

Following those storms, the state of Texas engaged in a coordinated planning process to address the situation of a large hurricane striking the Texas coast. The state established the city of San Antonio as a major regional coordination center (Alamo Command) for evacuation of the southern half of the Texas Gulf coast. Consequently, the San Antonio RMOC became a coordination center, not just for the immediate San Antonio area, but also for a large section of the state. The RMOC developed teams of deployable medical personnel that would respond to the threatened area and act as forward command and control elements for the RMOC.

In the summer of 2008, hurricanes Gustav and Ike tested that planning and expanded scope. The RMOC remained operational 24/7 for over four weeks. The RMOC deployed forward teams into the Rio Grande Valley when that area was threatened and

[68] Epley et al., "A Regional Medical Operations Center Improves Disaster Response and Inter-Hospital Trauma Transfers," 853–59.

[69] Ibid.

evacuation appeared necessary. The RMOC coordinated all medical resources coming into the regional command area. Food and shelter had to be coordinated for the transport staging area, which at one point had swelled to 525 ambulances. The RMOC created scores of "paramedic buses" by assigning a paramedic team to a bus in order to increase the transport capacity for medical special-needs patients. Several DMAT teams assigned to the area coordinated their activities through the RMOC.

In its command and control structure, the RMOC activated a hospital branch, a public-health branch, and an acute health-care branch. Evacuees from both Texas and Louisiana were streaming into the area, and their medical needs created an additional challenge for the RMOC.

The RMOC coordinated over two thousand patient moves during the two hurricanes. When hurricane Ike took a sudden turn toward Galveston and Houston, the RMOC also had to coordinate the movement of staged medical assets away from the no-longer-threatened southwestern part of Texas and toward Houston. Without the presence of a pre-existing RMOC, such herculean medical logistic challenges would have been difficult or impossible to meet.

D. HOUSTON[70]

Name: Houston Catastrophic Medical Operations Center (CMOC).

Main Sponsoring Agencies: Southeast Texas Trauma Regional Advisory Council (SETRAC).

Established: 2001.

The beginnings of the Houston CMOC go back to the start of the Houston MMRS contract in 1997. The requirements of the contract forced various agencies to plan together in order to meet the MMRS deliverables. These planning efforts led to the development of relationships and continued planning after the deliverables were

[70] The material in this discussion, except where otherwise noted, comes from the author's focus group with Houston CMOC representatives on May 13, 2008, and an interview with Doug Havron, SETRAC Director, conducted on November 6, 2008.

completed. The planning groups looked at lessons learned from other incidents, and EMS desired some type of central coordinating entity.

The sentinel event for the CMOC development occurred in June 2001 with the arrival of tropical storm Allison and severe flooding that devastated Houston. Several hospitals in the Texas Medical Center flooded and required evacuation, a massive undertaking. The hospital system was crippled, and two main entities spontaneously arose in an attempt to coordinate resources. This actually created confusion and chaos as the two entities failed to communicate and vied for the same resources. The after-action review of the incident demonstrated an obvious need for one clearly identified medical coordination center. The MMRS planning groups, under the auspices of the Houston Office of Emergency Management, began developing that center.

The CMOC is currently located in the Houston EOC. The Houston EOC is actually an EOC that coordinates the efforts of departmental centers located elsewhere. Of the 44 positions in the Houston EOC, 13 of them are dedicated to coordinating the medical and pubic-health response to an incident, a testament to the value placed on the CMOC by the Houston Office of Emergency Management. Each position has several computer screens and an integrated headset, internal/external communications system. All the positions face a large display wall board whose images are monitored and controlled by a separate monitor control room. This allows the representative to visualize the large boards or select the boards he or she wishes to view from the smaller monitor at the position.

SETRAC and Houston Office Emergency Management jointly administer the CMOC. The Houston metropolitan area is divided into four quadrants for hospital planning with twenty to forty hospitals in each quadrant. Each quadrant has a seat in the CMOC. That seat is filled by a leader elected by the hospitals in the quadrant.

Upon activation, each quadrant is responsible for providing staff for its position. SETRAC and Houston Emergency Management also provide staff. Public health and EMS provide their own representatives. The City of Houston provides operational training for all CMOC representatives.

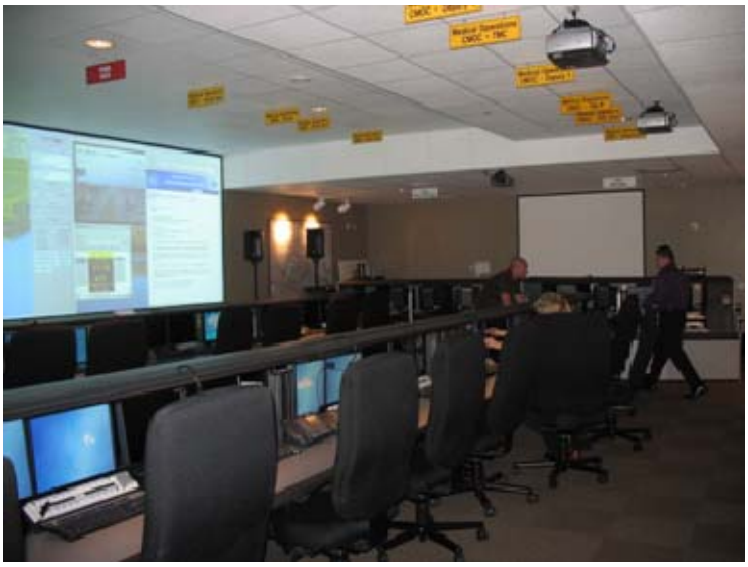

Figure 4. The Houston Catastrophic Medical Operations Center. (CMOC). (Photo by Mike Curtis, used with permission)

The primary mission of the CMOC is to protect the health-care system during a large incident. As an incident grows in scale, so does the type of response required. There are systems and protocols in place to handle the day-to-day management of the medical system. Even moderate incidents may be mitigated without the CMOC by corporate or regional sister facilities assisting a stricken hospital. The CMOC becomes engaged when the incident renders the "normal" systems ineffective and is large enough to affect the entire medical system to the point where an umbrella effort is necessary.

Like San Antonio, the Houston CMOC now figures largely in the state of Texas hurricane evacuation plans and incorporates much of southeast Texas. The capabilities of the CMOC were also put to the test during hurricanes Gustav and Ike in the summer of 2001. During hurricane Gustav, the CMOC assisted with the evacuation of medical special-needs patients from the Beaumont and Port Arthur areas.

There was a certain degree of confusion between the operational plan for the CMOC to coordinate ambulances and the governor's Department of Emergency Management's unilateral control of all resources. A meeting to work out those issues was cancelled due to the sudden arrival of hurricane Ike and the significant threat posed to the Galveston-Houston area.

The CMOC remained activated 24/7 for thirty-one days. Just before the hurricane's landfall, the 211 system shut down, and for some unknown reason the calls were forwarded to the CMOC for an eight-hour period. Once the storm's track became clear, numerous nursing homes and homebound patients were identified in the high-risk flooding area. In an amazing coordination of resources between the CMOC and the Forward Coordinating Elements, over five hundred medical patients were moved to safety during a 12-hour overnight period.

During the height of the storm, the Houston EOC lost power, which disrupted communications for twelve hours. Fortunately, redundant systems allowed the CMOC to continue operating. The CMOC continued to operate after the storm had passed. The extended power outage created additional problems for the medical system. Over two hundred nursing homes were evacuated to schools, medical special-needs shelters, or hospitals. The hospital system experienced a great many power issues. Although powered by generators, many of the generators failed from lack of available fuel or mechanical breakdown after weeks of operating. The CMOC had to coordinate the evacuation of fifty-nine hospitals during the weeks following the storm. Operating the CMOC for such an extended time presented staffing issues. Hospitals would not release assigned personnel, and the CMOC operated at times with minimal staffing.

Throughout these incidents, the Houston medical system was affected to the point that the normal mechanisms failed. Facilitating the hundreds of immediate action items needed to take care of the patients in the system would have been impossible without a medical coordinating center like the Houston CMOC.

V. PROPOSAL FOR A NATIONAL MOC NETWORK

In the previous sections of this thesis, I have outlined the differences between the medical and public-health systems, their similarities, and their complexities. I have also demonstrated the need to provide an augmented means of coordinating the prevention, response, and recovery activities of a medical system whose key elements are numerous in number and expansive in scope. I have also shown how the current health-care environment will make this coordination even more challenging as the future unfolds.

I have provided several tangible examples of how some jurisdictions have addressed this coordination challenge and mitigated actual disaster responses. Many know the problems, and the mechanisms to solve the problems in the form of medical operations centers are gradually evolving around the nation. This evolution, however, is sporadic, haphazard, and lacking in consistency of mission and focus beyond the actual or perceived needs of the local or regional jurisdiction—a dangerous proposition in the face of multistate or national calamity.

There must be a nationally driven program to assist local jurisdictions and state governments in creating such coordination centers. This program must provide leadership, guidance, consistency, and support in an effort to build a national network of medical operations centers. The medical operations center will not only meet local needs but will serve as a hub of coordination and information for a statewide or national response.

Medical operations centers already exist in numerous local jurisdictions and their constitution, structure, and mission vary from place to place. Some existing centers combine both medical and public-health system activities under one roof, while others are very parochial and protective of their single medical-system coordination role.

The creation of such a networked system will certainly face some significant challenges. Many of the struggles encountered by the existing centers will occur in the creation of a national network: apathy and the need for buy-in; and concerns over the duplication of effort, organizational structure, funding, authority, mission and scope,

competition, and physical space. These challenges can be overcome, as demonstrated by cities such as Houston, Oklahoma City, and Boston.

The question of whether or not to build the system is also moot; the system is being built now at the local level—it just needs direction, support, and consistency in order to achieve a national level capability. Given the potentially catastrophic threats that the nation faces, and the fact that centers are now being formed, national leadership has an excellent opportunity to create a network that will serve the medical and public-health systems well into the future. Success lies in leadership and authorities, a focus on consistent functions, organizational and financial support, technology, and recognition of both formal and informal communications mechanisms. I will outline below just how easily that might be accomplished.

A. LEADERSHIP

The government of the United States was established as a federal system with much of the responsibility for governing reserved for state governments. This has led to a natural reluctance or legal prohibition for federally driven projects that dictate how states should operate. This reluctance is present in the various federally funded preparedness programs. The federal agency provides very general guidelines and permits the states or local communities to plan, produce, and procure to meet their own needs within those guidelines. While this is ostensibly done because the states know their citizen's needs, it often leads to a menagerie of different structures and equipment that is not interoperable with other states or national entities. One has only to look at training programs or databases such as those found in the ESAR-VHP program to see this in action. Since situational awareness and rapid decision making processes are essential to a large scale medical response, interoperability in the medical operations centers around the country is crucial. While some regional specifics can vary, there must be consistencies in communication pathways, resource typing, and at least a minimal number of functional capabilities.

The leadership for such an ambitious project must come from the federal level. A large-scale, long-term, consistent vision at the national level, expressed and supported by

key leadership in the federal agencies that share the responsibility for protecting America's health, is required. Just as important, leadership must be demonstrated in both the legislative and executive branches in order to allow the officials to perform the work needed and to ensure that funding continues for the development and sustainment of the network.

Federal officials should be cautious about prescribing and dictating the formation of the network by means of mandate. A mandate may accomplish compliance and the quicker formation of a network, but it may not allow the collaboration and buy-in needed to sustain success at the local level. The federal government may select the designated and/or funded cities and thus lay out the plot of the network, but the emphasis should be on a communicated need, purpose, and vision combined with minimal required functional capabilities and communication pathways. The sharing of lessons learned from those jurisdictions that have already implemented an MOC and examples of best practices and successful utilization during an actual response will also assist in the development of the national network.

Horizontal collaboration and communication at the national level will also assist the local and state jurisdictions trying to develop a medical operations center capability. Explaining the project's purpose, scope, and functions can lead to acceptance, understanding, and support from professional organizations, who can communicate to their respective membership bases at the local and state level. American Hospital Association support at the national level can result in an increased willingness by local facilities to either take a leadership role or at least participate in the formation of an MOC at the local level. Likewise, demonstrating to the International Association of Emergency Managers that the MOC does not replace, but augments, an EOC may remove potential resistance from emergency managers at the local level.

One of the first actions that can be taken at the federal level in concert with the development of an MOC network is to recognize and acknowledge the difference between the medical and public-health systems and to restructure ESF-8 in the National Response Framework to reflect those differences. The consensus of those surveyed and interviewed was to keep health and medical within the same emergency-support function,

but ESF-8 needs to have separate sections for medical and public health. One section would encompass functions consistent with care provided to an individual while the second section would encompass those community-based functions normally performed by public-health agencies. A third section could include the medical special-needs patient response and other functions that do not fit neatly into either of the first two sections.

The federal government can also take an immediate step towards building the MOC network through the various grant programs that provide significant funding for medical and public-health system preparedness. These grant programs, most of which already hold interoperable communications as a priority, can further define that grant focus area as an explicit desire for a medical and public-health coordination capability. Either through a directly expressed intent or through using the functional components that will be outlined later in this chapter, the grant guidelines can provide direction and initiate thought and action toward the establishment of both an MOC and a link with other centers in nearby jurisdictions.

Effective leadership at the local, regional, and state levels is just as important. The medical operations center's primary purpose is to serve the local and regional health system during a mass-casualty incident or a public-health emergency. Consequently, the local and/or regional establishment of an individual MOC will be the primary link to any national network for medical-system coordination.

One of the most important facilitators for successful collaboration is the presence of a "champion," an individual with the drive and respect to keep the development process going through slow periods and over the unavoidable hurdles. While the creation of a national network of medical operations centers will certainly require leadership and direction from the federal level, it is the leadership of the individual medical operations center, supported by local, regional, and state partners, that will ultimately determine the degree of success of the MOC. Any national network will only be as strong as the sum of its individual MOCs. Thus, local and regional capability must be established in order to create a strong national network that will serve all the health-care systems in the nation. Ideally, a local or regional champion, in the form of an individual, group, or agency, will initiate the formation of a medical operations center. That champion needs support from

both the local health-care system, as well as state and federal government agencies, and must be allowed to lead the formation process. The leadership group overseeing the formation of the medical operations center must be aware of the needs and desires of the health-care system and must establish the center's purpose and organizational structure so as to meet those needs.

While the national network may be built through a federal vision and funding combined with a local and regional grassroots development, state government must also demonstrate leadership and a willingness to become an integral part of the network. The federal system imparts significant authority and responsibility to state government. Any particular state government can become a powerful facilitator of the network or or an impediment by inhibiting the formation and/or participation of local and regional medical operations centers. A state-level medical operations center can act as a coordination element between the local and federal levels and offer effective span of control and compilation of reportable information and data. The local and regional medical operations centers can report up to the state-level MOC. This will create a statewide network of medical operations centers that may be all that is needed to manage a regional incident. Done correctly, the national network would be a "network of networks," with the hub points being the state-level MOC.

In states with large rural areas, the state MOC could act as the default MOC for those medical facilities. These areas may lack a clearly identified concentration of medical resources and/or referral centers and would rely on the state MOC for information and resource coordination.

While the state MOC would be a hub, with information coming in from the local and regional MOCs, each regional MOC will need to be able to communicate with the others within the state, and possibly with neighboring MOCs in other states. The federal government may need to communicate directly with a local or regional MOC. While the control of the information flow and resource utilization is important, the state will need to be mindful of the other communication pathways between MOCs and avoid regulating or restricting information exchange between MOCs in an effort to assert total control of all information. This informal information exchange will likely occur anyway and should be

encouraged. This will likely require a degree of leadership on the part of state personnel to move away from the traditional hierarchical reporting structure.

B. AUTHORITIES

In order to function, each MOC that makes up the network will need some degree of authority. It will also need to be the unique coordination center for that local jurisdiction, region, or state. There are numerous ways of providing the needed authority: statute, directive, regulation, grant requirement, plan, mutual benefit, and perceived value. Any one, or combination of authorities, may be needed to ensure that the proper level of participation is received from the medical community.

The strongest authority comes from legislative or governing bodies that enact rules requiring participation in an MOC. Laws can be passed, directives can be issued from executives, or regulations enacted requiring participation. While this can be very effective in empowering the MOC, the process can be difficult, inflexible, and time consuming. One must also be mindful of the statements of one focus group that mandating the hospital system may result in compliance but not overt cooperation. The requirements could get lost in the sea of other regulations that burden the medical system.

The existing authority held by public-health agencies at the state and local levels is one of the arguments for combining the MOC and the public-health coordinating center. There may not be a need to create authority; it may already exist within the public-health agency.

Less effective but more easily accomplished are grant requirements and planning and procedure documents. By placing the establishment of an MOC within some federal or state grant requirements, local jurisdictions may be willing to investigate the idea. If a facility needs to participate in order to receive preparedness funding, it will at least look at the concept. This process is conditional, and the MOC may not get any attention beyond checking off a box on a report to secure funding. Facilities may also look at the participation as an additional workload of unknown scope and choose not to participate in the funding program altogether, a highly undesirable outcome. Placing the MOC into

emergency response plans may eventually engrain the MOC into the response culture and provide the needed level of authority and participation. Participation will occur because "that's the way it has always been done" or there are written plans stating that is what needs to happen. The plan-insertion method requires some initial development, a means to sustain the minimal operational capability, and a great deal of time. Real success will likely occur from the last means of achieving the needed authorities: mutual benefit and perceived value.

Any organization will seek out and participate in an activity or pursuit if it feels there is a benefit to that particular organization. Groups of organizations are more likely to interact and participate in a joint activity if there is a mutual benefit for all from that activity. The medical system is no different. The most potent means of obtaining true authority as well as willing participation and eager support is to demonstrate how the MOC serves the interests of the medical community. Once that has been accomplished, the MOC will be supported and defended by the medical community and will be easily established as a critical and powerful element of the response infrastructure. This benefit must be described, demonstrated, and consistent. The MOC must establish a level of credibility within the medical system. Once established, the MOC must maintain the level of performance expected by the medical community. Plans must be achievable and performance consistent; freelancing and sidestepping the expected processes should be discouraged lest the medical community become uncertain of the MOC's capability and therefore of the parochial benefit to itself. The heart of the performance of the MOC will be its self-described functionality—what it does for the medical community and how the network of MOCs will benefit the state and the nation.

C. MOC FUNCTIONS

Because there are many medical operations centers already existing around the nation, in many various forms and capabilities, it would be imprudent to attempt to build the national network by prescribing in detail exactly where and how an MOC should be established, where it should be located, who should manage it, and other specific details. The building blocks for consistency throughout the network are a specific set of functions

performed by the MOC regardless of its location and structure. If every MOC in the nation can perform a certain set of tangible functions, consistent from the local MOC through the state and up to the federal level, the network will then have a defined purpose, a clear scope, a consistent mission, and it will become a vibrant entity with a clear benefit to the medical system at all levels. Because the network will be strongest by creating a two-way flow of information and coordination, the functions of the MOC should clearly serve two purposes: to meet the needs of the local or regional medical system, and to meet the needs of the state and federal agencies responsible for overseeing and coordinating a response. I will discuss some of the basic functionalities needed by each MOC below.

1. Primary Point of Contact

The MOC should be the primary point of contact for the particular medical system it serves. In areas where public-health coordination occurs in a different location, a strong liaison with the public-health agency will need to be forged and clear areas of responsibility delineated. There cannot be duplicative centers, each believing it has operational responsibility and thereby creating confusion for the medical system. The MOC should be identified, tangible, and easily accessible on a 24/7 basis. The medical community must be aware of the MOC's purpose, limitations, means of access, and functioning. State and federal authorities will also need to know the locations of the MOCs and their areas of responsibility. A federal or military response team's medical component should be able to hit the ground and contact the MOC in that area for a situational update and medical intelligence. The functionalities of the MOC cannot be buried inside an obscure set of agencies and departments; the functionalities must be centralized and transparent.

2. All-Hazards Approach

The MOC must be prepared to provide its core functions during any type of response. Consequently, it must reach out to all elements of the medical system in order to have the contacts and familiarity to meet the needs of the entire medical system. The

MOC should not be designed for a particular part of the medical system. It must be flexible, adaptable, and capable of addressing whatever needs arise. In 2007 a major ice storm hit Oklahoma City and created long-term power outages to the entire metropolitan area. The Oklahoma City MERC activated initially to address the perceived needs of the hospital and EMS system from an increased patient load and transportation challenges. However, the MERC found itself staying operational for ten days in order to meet the needs of long-term-care facilities, dialysis units, homebound patients, and carbon-monoxide-exposure patients.

3. Situational Awareness

A vital function of the national network will be the ability to quickly and reliably obtain a consistent level of situational awareness. This function will begin at the local or regional level and should permeate the entire network up to the federal government. The situational awareness will involve a two-way flow of information: local medical systems will want to know the bigger picture in the state and the country, while state and national leaders will want a compiled assessment of local situations in order to form that bigger picture. Situational awareness means different things to different people. I will briefly describe how the MOC can function in three elements of awareness.

a. Common Operating Picture

The medical system frequently operates “in the dark” during a sudden disaster that creates mass casualties. The system tends to focus on its own existing patients, new patients coming into the ED, EMS triage/transport, and the particular threats and problems unique to its own facility. The MOC, through its connections with the ICS if there is a scene, and the other components of the medical system, can gather the status reports, scene descriptions, challenges and opportunities found and can compile an operating picture. That operating picture can be shared, through text or video, with all the elements of the system at the local, regional, state, or federal level. Conversely, the MOC can receive the operating picture from the state and federal agencies and relay that information down to the local level. The MOC can produce an incident action plan for the

medical system that incorporates local, state, and national goals. Even during a slowly evolving public-health emergency, the MOC can monitor the effects of the infectious or toxic agent on the medical system, inform local, state, and federal public-health agencies, and in turn relay public-health information and desired actions from all levels of the network to the medical community.

b. Intelligence

Natarajan argues for a medical intelligence center at the national level that supports many of the observations in the present research project.[71] The national network of MOCs could become a provider of information to a national intelligence center. Combined with public-health information, the flow of medical system assessments, information, and local/state operating pictures fed up to the national level would allow for a compiled and processed intelligence report and a solid national picture of an incident's effect on the nation's medical systems. Conversely, the national network of MOCs would provide a rapid, reliable, and secure means of distributing processed information from state and federal authorities to the elements of the medical system that need the information. As mentioned earlier, medical response resources sent into an area can obtain local intelligence from the area's MOC.

c. System Assessment

The MOC would be in the best position to provide an accurate assessment of the status of the medical system. Collectively, through the network, authorities could gain a picture of the overall impact of an incident on the system; this information would facilitate informed decision making and optimal resource allocation. Assessing the impact of an incident on the medical system presents a significant challenge for the authorities coordinating a response. The medical system has many agencies and facilities, and the staff members working in those facilities have their own individual opinions of how the system is affected. Someone needs to be able to get beyond anecdotal exhortations resulting from stress to make an assessment of a collection of information.

[71] Natarajan, "National Imperative to Establish a Domestic Medical Intelligence Center."

Ideally, this assessment should be applicable across the entire network so that the rolled-up assessments are all founded on the same baseline and the compiled data is not simply an accumulation of dissimilar bits of data.

One such system for quantifying the stress on the medical system is the Hospital Status Survey, or HOSS, developed by the Oklahoma City MMRS. The system is predicated on the assumption that a hospital's level of stress can be determined by the internal actions taken by the facility in reaction to the external event. The hospitals answer a short series of questions from the MERC. The answers to the questions are assigned a numeric value. That value is compiled for the facility, and the collection of hospital scores is compiled for a system score. If the system seems to be headed into a stressed status, additional questions are asked in order to further drill down on the hospitals' reaction. Table 20 shows the questions asked and the scoring format. If a particular facility receives a score close to a set threshold, the Oklahoma City MERC will call the facility to gather additional information. The system has the benefit of reminding facilities of potential actions they can take in response to an increase in patient volume. The HOSS also assures that the facilities have done all they can do internally before bringing in outside intervention. It is also a means of providing a quantified score that can be compared with other scores from MOCs across the network, thereby providing a consistent and valid assessment.

Table 20. Sample HOSS Form.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
1	Region Six and Eight																									
2	Hospital System Survey																									
3	Date																									
4	Hospitals>>>>>	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
5	In the last 24 hours, has the facility experienced any of the following problems?																									
6	Holding ICU admits in ED due to lack of facility beds?	1	1	1	1																					
7	Holding floor admits in the ED due to the lack of facility beds?	1	1	0	1																					
8	Staffing shortages from absenteeism?	0	1	1	0																					
9	Actual/anticipated equipment shortages due to volume of patients seen?	0	1	0	0																					
10	What actions, if any has the facility taken to address the current situation?																									
11	Hospital EMS diversion due to overloaded ED?	0	1	0	1																					
12	Hospital EMS diversion due to lack of critical care beds?	0	1	0	1																					
13	Increased number of staffing hours due to volume																									
14	"ED?	0	1	0	1																					
15	"Critical Care?	0	1	0	1																					
16	"Floor?	0	1	0	0																					
17	Mask usage on waiting room patients and families?	0	1	0	1																					
31	Hospital Totals:	2	10	2	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
32	# of Hospitals Participating: 4																									
33	Total system points: 21																									
34	HOSS Score: 19																									

4. Communication Pathways

Another critical function for every MOC is the establishment of pathways for communication flow. These pathways can be formal or informal, vertical or horizontal. Formal communications consist of prescribed and planned communication flow between facilities, the MOC, and the network. These are the hierarchical communications and reports in written, web-based, or verbal form that are planned, documented, and usually part of a command and control infrastructure. The informal communications occur between and among the medical system and the MOC network. These are the "off-line" discussions between interested parties who often have a preexisting relationship. This informal line of communication is far less hierarchical and often discouraged by those monitoring or in charge of the formal communication flow.

Vertical communication is the two-way flow of information from the local agency to regional, state, or federal agencies and back down again. Horizontal flow is the communication flow between MOCs at the same level in the network or between two entities in close proximity to one another. The formal vertical flow of information is often pushed by planners and command staff and is most frequently found in response structures and networks; usually at the exclusion of other types of communication flows. The reason given is safety and control, but often the result is delayed decision making, incomplete information, and a partial operating picture. The MOC network needs to make full use of all the available communication flows in order to respond rapidly when needed and to ensure a complete picture of the situation. For example, Lawton, Oklahoma and Wichita Falls, Texas each have an MOC and are separated by twenty miles, a state line, and the Red River. Both MOC leaders established a relationship and opened lines of communication between the two centers—something discouraged by state response personnel. An incident at Ft. Sill, Oklahoma could produce multiple casualties. Instead of communicating with a hospital coordinating center twenty miles away, the Lawton MOC would have to contact Oklahoma City, who would contact Austin, who in turn would contact Dallas, who would then get the information from Wichita Falls. Then the information flow would have to return via the same circuitous route before one question could be answered, "Can I ship patients across the river to your hospital system?"

The NDMS system flooded the Little Rock hospital system with evacuees from hurricane Ike in 2008 to the point of collapsing the entire Little Rock hospital system. If Little Rock had had an MOC, and had established communications with Oklahoma City, Tulsa, and Memphis, perhaps this horizontal communication flow would have found solutions to Little Rock's challenge and diffused the hospital system through patient transfers to those nearby systems. Once the MOC network is created, the various forms and levels of communication should be acknowledged and embraced. While a formal vertical network may necessarily be the primary pathway, the other, often more effective, communication relationships should not be ignored.

5. Patient Distribution

One function that seems relatively consistent among the current functioning MOCs is the ability to determine patient flow and destination. Normally, the local EMS service, utilizing existing protocols, determines the end destination of out-of-hospital patients as well as patient transfers. During a mass-casualty incident, disaster, or public-health emergency, that decision process is often relegated to the MOC. The MOC has communication with each destination facility and can determine real-time capacity. That information is utilized to inform the transport officer at the scene of the ideal destination for a particular patient. Patient movement coordinated through the MOC is not restricted to a mass-casualty incident. In fewer than 12 hours, the Houston CMOC facilitated the movement of 500 LTC and hospital patients threatened by flooding from hurricane Ike in 2008.

6. Resource Coordination

Another critical function that every MOC should be capable of performing is the task of coordinating resources for the medical system. When the formal (purchased inventory) and the informal (facilities borrowing from each other) inventory systems cannot meet the need of the facilities, then the MOC is the next point of contact for a facility. Depending on the need, the MOC will either find the needed items in another facility, another component of the medical system, available cache, or request the items

through the emergency management resource process. In a truly functioning national network, the MOC could also look outside its own jurisdiction for a needed item and contact a neighboring MOC within the network. The MOC should be responsible for following up on any valid request from the medical system and reporting the status of the request on a regular basis. During large-scale incidents, the MOC may act as the coordinating entity between the Strategic National Stockpile (SNS) warehouse and the medical community that needs supplies from the SNS. To facilitate the resource-coordination efforts, hospitals and other medical-system agencies and organizations should enter into a memorandum of understanding that provides the terms and processes for sharing available supplies and equipment. There should also be additional work done on typing medical equipment and supply resources as part of the National Incident Management System so that the MOC network can have a consistent and standardized idea of what is being requested and supplied.

7. Response Solutions

The last function of the MOCs in the network is the miscellaneous role of "problem solver" or problem resource. The MOC should be the one-stop location for significant needs from the medical community when the individual facility is no longer capable of meeting those needs. Sometimes the problems can be solved; sometimes it will not be resolved. But in order to build some of the perceived value and accompanying authority and participation from the medical system, the MOC should be willing to take on this chore in a controlled manner. The medical system must also realize, through MOC education and communication, the limits of the MOC. While the MOC will certainly attempt to solve problems, the medical system should not hold the MOC responsible for finding solutions to all problems.

These seven key functions should be shared by all MOCs in the national network at all levels. Other functions may be provided by the MOC to meet the particular needs and unique characteristics of the local or regional medical system. By focusing overtly on the functions performed, the network can be constructed with the existing MOC, as well as new organizations willing to take on the role of medical system coordination. The

focus on function will mean that it will not matter which agency acts as the "champion" or provides space or oversight, as long as that agency can provide the functions mentioned above.

D. SYSTEM DESIGN

The first step in the system design will be to decide where to locate the MOCs in the network in order to provide the greatest coverage to the medical systems and population in the nation. Along with that decision, the federal government should determine whether any existing preparedness programs already exist that could assume this important project. I would posit that the Metropolitan Medical Response System (MMRS) Program, currently under the U.S. Department of Homeland Security (USDHS) makes an excellent match on several fronts. The 124 cities and jurisdictions of the MMRS cover the majority of the nation's population and a significant number of the medical systems in the country. The original intent of the program was to fund a medical response mechanism in the nation's metropolitan areas—where the vast majority of medical systems also exist. The MMRS program is also undergoing some suggested potential changes that will dovetail nicely into the establishment of a national network of MOCs: a risk formula based upon population, a nexus with emergency management, and an expansion to cover all fifty-six states and territories. Medical systems and population centers usually go hand in hand;: the MOC is an extension of the ESF-8 seats in an EOC and integrated with the rest of emergency management; the expanded coverage will incorporate all the medical systems in the nation. The current MOCs are frequently located in jurisdictions with an existing MMRS program. The MMRS program, with the MOC National Network Project could serve as a bridge between the medical programs in USDHS and those within the U.S. Department of Health and Human Services (USDHHS). Other funding programs, such as the Urban Area Security Initiative (UASI) under USDHS or the Assistant Secretary for Preparedness and Response (ASPR) program under USDHHS could also be used to support the formation of the MOC network. However, the MMRS program appears to have the best fit of mission and existing relationships with the metropolitan areas and medical system within those areas.

Once a basic map of the desired locations for an MOC has been identified, the current MOCs must be assessed for the functionalities listed above; areas without an MOC must be encouraged to establish a medical-system coordinating center. The process can be a top-down approach, a bottom-up approach, or a combination of the two. A top-down approach would involve establishing the federal center, which can be the Operations Center at ASPR, then determining the role of the federal regional offices, which must possess the core functionalities of an MOC. The next steps include developing and identifying state MOCs and finally the various metropolitan MOCs to complete the network. The top-down method would be easier at first, since much of the work has been done, but this method would potentially delay the establishment of MOCs at the local and regional level—the ultimate source of the desired information for a national picture of what is occurring in the medical system.

A bottom-up approach, on the other hand, would concentrate on getting the local and regional MOCs established first, then building the network at the state, regional, and federal level. While the bottom-up approach would form MOCs at the grass roots level, the lack of a state or regional center to which to report might inhibit the continued success of the local MOC. The state might not be interested in assisting, and the communication flow might necessarily bypass state officials and go directly to the regional or federal level—not a good proposition for continued state support.

The most likely approach is probably a hybrid of the previous two approaches, where existing MOCs are incorporated into the development of a state MOC, while additional metropolitan areas come online with their own newly established MOC. Regardless of level, the MOC system will face certain common issues, such as geographic scope, location, funding, staffing, operational guidelines, and the use of technology. The medical operations center will also need an agreed name, so that everyone in the national response structure will be talking about the same function-based coordination center.

1. Geographic Scope

One of the first steps will be to determine the geographic area covered by an MOC. At the local level an MOC's geographic area should mirror that of the medical system and will usually be regional. The medical system usually does not recognize the borders of individual cities or counties and is determined by population densities and the physical location of the major facilities. A "catchment area" or referral area can usually be defined by the individual facilities and can serve as the geographic boundaries for the MOC. In some heavily populated cities such as Houston, the catchment area involves so many facilities that one area may have to be subdivided into smaller subunits for realistic control. Large rural areas may not have any particular defined catchment area, but they may still have an MOC located in one of the larger cities in that rural area that covers numerous counties and the individual health facilities located in the those counties.

The state MOC geographic area should be easily determined as the borders of any particular state. However, there may be alterations depending on the medical systems and their locations. Medical systems don't always respect state boundaries either. The medical system in Kansas City, Kansas may be more effectively coordinated by the MOC in Kansas City, Missouri—a fact that alters the geographic coverage area of both states. The federal and regional areas are also already clearly defined and should remain consistent with their existing geographic boundaries.

2. Location

As long as the core functions are present, and those functions are known and accessible to the medical system, the actual physical location of the MOC is not prescribed. MOCs are currently located in 911 centers, emergency operations centers, hospitals, stand-alone locations, and combined with public-health operations centers. While an MOC can function in a variety of locations, certain considerations should come into play, particularly if the leaders of a medical system are embarking on the creation of an MOC.

The amount of space dedicated to performing the functions does matter. Most MOCs contacted during the research bemoaned the initial underestimation of space required for the center. Sometimes the amount of space was not negotiable: it was dictated by what was available. Anecdotal experience from some of the existing MOCs demonstrates that there should be enough space for fifteen to twenty people to operate comfortably for extended periods of time.

Although the medical system is distinctly different from the public-health system, the two are inexorably linked in so many ways that the combination of public-health operations functionality and medical system functionality located in the same area was the preferred means expressed by those surveyed. This may not be possible for a number of reasons: politics, interagency competition, parochial protection of one's "turf," limits on existing space options, finances, or the space requirements required for both public-health and medical system coordination. The number of people and the amount of space required to manage the logistic supply and operations of twenty mass prophylaxis locations, combined with the coordination needs of twenty overwhelmed hospitals and five very busy EMS agencies may exceed the space available. However, if it can be done, placing both functional areas under one roof is desirable and proves to be the best way to maintain an easy linkage between the two systems.

Another location option is to locate the MOC with an existing emergency operations center (EOC). A large number of MOCs currently in operation have moved to an EOC, or they have developed inside an EOC as a means of increasing the space and activities formerly conducted by the two or three previous ESF-8 seats. Being located with an EOC has the distinct advantage of providing immediate assessments of the impact on the medical system to the policy group, obtaining and relaying incident situational awareness to the medical system, and having a means readily at hand to obtain needed resources. The EOC co-location may also help defuse some concerns from emergency managers about the MOC's being a duplicate coordination entity. One challenge, depending on the EOC coverage area, is the need for the MOC to coordinate

with multiple local EOCs that have hospitals or clinics in their jurisdiction. Ideally, the MOC would be located in a regional EOC whose coverage area matches that of the medical system covered by the MOC.

Placing the MOC within an existing 911 center has been chosen as an option by several jurisdictions. This option allows for rapid interaction between the field medical units and the MOC. There is a significant caveat to placing the MOC within the 911 center, however: consoles, and the use of existing personnel for staffing. Most 911 centers in large metropolitan areas utilize computer-aided dispatch (CAD). The personnel sit at consoles, or stations, while performing their duty. This design, while quite efficient for daily operations, does not readily allow for rapid expansion of personnel assisting during a disaster. Any available console and/or personnel may be tied up answering the flood of 911 calls for assistance or dispatching units at the expense of system coordination. There must be clearly dedicated space and staff to perform the coordination function. The MOC established inside a 911 center may have been established to coordinate a segment of the medical system during a sudden mass-casualty incident, and it may not be designed to coordinate the complex medical-system needs of a widespread, slowly evolving, long-term incident that taxes the entire medical system.

A hospital may be an option for the location of an MOC. Hospitals frequently have the space needed and often can provide the necessary technical and administrative support. Hospital staff can also provide either initial or back-up staffing for an MOC. The hospital as a location may present a challenge if the hospital system is competitive; some hospitals may refuse to participate, fearing unfair treatment from the center. The MOC inside a hospital would also be dependent on the support of the facility's administration—sometimes a fleeting prospect.

A final consideration when choosing a location for the MOC is the dual use of an existing space. The medical system is replete with entities that either perform as a referral center, such as a trauma call center, or provide clinical expertise, such as a poison control center. These call centers already have much of what is needed in an MOC: space, technology, and personnel. Existing call centers may be able to provide sudden on-call medical-system coordination for short periods with their existing personnel. This method

can allow an MOC to get up and running quickly, but eventually the call center will need to go back to providing the service for which it was initially designed.

Even if the call center's dual use does not work out, there is also the option of using existing space whose initial purpose can be delayed or moved to a different location if the MOC needs to be operational for an extended period of time. The Oklahoma City MERC started out sharing space with an EMS training room. The Tulsa MERC's initial location was a police briefing room. The space can be wired with the needed technology and can be rapidly converted to an MOC should the need arise. Regardless of how it is done, the dual use of existing space can significantly reduce the initial cost of establishing an MOC—an important consideration.

3. Costs and Funding

The initial development and sustained operating costs are critical considerations for any new endeavor, and the establishment of a local or regional MOC is no different. A medical operations center can be developed for a relatively modest cost, particularly when that cost is weighed against the benefits to the medical system of situational awareness, appropriate patient destination, and effective utilization of resources. Several strategies can be employed to reduce or mitigate the costs of establishing a medical operations center: dual use, on-call escalating status, grant funding, and either municipal or health-care system support.

Dual use of existing facilities has been discussed earlier. By sharing existing space, the costs for the space and the personnel can be absorbed or shared by another functioning entity, such as a trauma call center or a poison control center. The net cost for performing the functions of a medical operations center theoretically can be incorporated into the cost of that alternate function. This may prove impractical if the two functions need to operate simultaneously. However, sharing mutually exclusive space such as a lecture hall or a training room may assist in reducing the overall cost of the MOC.

Developing an on-call and escalating operating structure for the MOC may also result in cost savings. The MOC remains in a stand-by mode and is activated during an

incident that requires coordination of the medical system. Once activated, a small number of personnel respond to staff the MOC, assess the situation, and determine additional staffing needs. This approach will save on any expenses associated with personnel required to operate the MOC, but it runs the risks of being slow to respond and of not having enough personnel present to meet the needs of the system during the early period of an incident.

Numerous grant programs are available to assist with the formation and operation of an MOC. The MOC can be considered a means to address important components of several national priorities[72]. The costs of establishing and operating an MOC should be easily justifiable under the many grant programs provided by the U.S. Department of Health and Human Services[73] and the U.S. Department of Homeland Security[74]. Some of the federal grant programs currently available to fund part or all of the MOC costs are given below.

Assistant Secretary for Preparedness and Response (ASPR)

Medical Reserve Corps (MRC)

Interoperable Emergency Communications Grant Program (IECGP)

State Homeland Security Grant Program (SHSGP)

Law Enforcement Terrorism Prevention program (LETPP)

Citizens Corps Program (CCP)

Transit Security Grant Program (TSGP)

Intercity Bus Security Grant Program (IBSGP)

Public Safety Interoperable Communications (PSIC)

Centers for Disease Control (CDC)

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[72] United States Department of Homeland Security, “National Preparedness Guidelines.”

[73] United States Department of Health and Human Services, “The Hospital Preparedness Program (HPP).”

[74] United States Department of Homeland Security, “FY 2009 Homeland Security Grant Overview.”

Urban Area Security Initiative (UASI)

National Association of City and County Health Officials (NACCHO)

Operation Stonegarden Grant Program (OSPG)

Metropolitan Medical Response System (MMRS)

Port Security Grant Program (PSGP)

Emergency Management Performance Grant Program (EMPG)

Buffer Zone Protection Program (BZPP)

These federal grant programs, along with numerous other non-federal community endowment and grant programs, afford many opportunities to fund the establishment of an MOC.

Oklahoma City established its MOC in 1999 at an initial startup cost of $30,000 funded from the MMRS grant program. The initial MOC, locally called the MERC, was established in the training room at the EMS headquarters. The funding was used to purchase computers, phones, furniture, radios, and communication lines for 25 positions. If needed, the dual-use room could be rapidly converted to a functioning MOC in about 15 minutes.

Municipal and state governments may also contribute to the costs of establishing an MOC. Once the benefit to the community and the means of obtaining situational awareness is revealed, many jurisdictions will provide the space and equipment in order to have the MOC located within the local or regional emergency operations centers. Oklahoma City, Tulsa, Lawton, San Antonio, Houston, and a host of other jurisdictions, have all provided space for and incorporated the MOC into the operations of their emergency operations centers.

The medical community can be another source for funding or a means to offset expenses for the MOC. A medical facility or organization can contribute to the MOC in many ways: funding equipment, providing space, and facilitating developmental and operational planning meetings. A component of the medical system may also be operating a call center or some other coordination entity and may be willing to absorb the

additional costs associated with performing the core functions of an MOC. Once the medical system understands the value that an MOC can provide, it will have a vested interest in ensuring the MOC's continued operation.

4. Staffing

The medical system can also provide one of the most valuable and expensive components of operating an MOC—staffing. One of the most difficult challenges faced by developers of an MOC is the identification and training of individuals who will staff the MOC during operations. One of the very reasons for creating an MOC is to expand the operational capacity to manage the myriad of agencies and entities that compose the medical system—hence the need for an adequate number of personnel on hand when the MOC is up and running. The number needed will depend upon the size and scope of the incident and the number of agencies and organizations involved.

At the local, regional, or state level, it will likely be cost prohibitive to maintain dedicated staffing for an MOC; the staffing will likely have to come from somewhere else. If the MOC is located within a staffed entity, such as a trauma call center, the staffing present may be adequate for the initial response; the individuals present will just shift their collective duties to that of the MOC. The organization that hosts the MOC may have personnel that are dual tasked and can respond to the MOC once the need for activation becomes apparent. Many MOCs are not staffed on a routine basis and require either staffing for the initial response or augmentation staffing for an extended operation.

The medical system can provide the additional personnel for the MOC operation. It may also be in a medical organization's best interest to assign staff to operate the MOC. This would provide an individual on the insideto ensure that the parent organization receives the information it needs. Operating the MOC with donated or volunteer staffing incurs the risk of not having trained staff available when needed. Faced with a disaster, the medical organization may withhold the promised staff or send other individuals less trained and experienced. Scheduled volunteers may not arrive. A long operation may create a fatigue that erodes the support and availability of outside staffing.

In any of these cases, the effectiveness of the MOC may be impeded, to the detriment of the entire medical system. Those responsible for scheduling on-call or reassigned staffing should err in favor of higher numbers to account for possible no-shows. Not only does the MOC require an adequate number of staff, but those working in the MOC also need to be trained and familiar with its internal operations and with the external response plan for the medical system.

5. Planning and Operational Guidelines

While the capability to perform a standardized set of internal functions, as mentioned earlier, is important to achieve some degree of consistency within the system, the MOC network will need to have some degree of common operating definition of the external environment as well. Once this has been established by convention or regulation, a set of parameters will exist that will allow an individual MOC to operate in the manner required to meet the needs of the region or state while still performing in a manner consistent enough to facilitate the flow of information throughout the levels of the network. This common operating definition also provides a core section of the training provided to those individuals working within an MOC during a mass-casualty incident or public-health emergency. Not only is such an individual dealing with local or state needs, he or she must also have a conceptual idea of what is occurring at all levels of the network.

At the micro level, there are two specific understandings or definitions that should be consistent throughout the network: the minimal elements of the medical systems whose activities will be coordinated, and the minimal set of information that will be requested and provided through the network. At the macro level, the external environment should be consistently defined in both a vertical and horizontal manner.

Because some MOCs may currently exist to coordinate a hospital system only, the minimal medical-system components should be clarified and defined so that a baseline level of monitoring, coordination, and information exists throughout the entire network. While any agency, organization, facility, business, or individual whose endeavors pertain to a patient’s individual care can and should be coordinated, there is a critical core of

medical-system elements that should be addressed by every MOC. These elements can be, and most likely will need to be, expanded based upon the incident, but for the sake of consistency, each local or regional MOC should interact with the following providers of patient care:

Hospitals and health-care organizations (HCO);

Emergency medical service agencies;

Long-term care facilities (LTC);

Pharmacies;

Large stand-alone clinics and federally qualified health centers (FQHC);

Public-health departments (if the MOC is not operated by a public-health agency).

This list should not be construed as being the only medical-system components coordinated by the MOC; rather, it represents the minimal set of patient-care providers that require constant MOC interaction. The MOC will still need to coordinate with other agencies, such as public safety and emergency management outside the medical system. Other medical-system components may rise to critical importance depending upon the type of incident and the affected population.

The standard template for information requests, once defined, allows each local and regional MOC to immediately gather a particular set of information and forward that information up to the state MOC for collation. The medical-system organizations can be trained to provide that information immediately upon MOC activation. State and federal agencies thus would have a consistent and rapidly collected data set that provides the initial medical-system assessments to be analyzed for the initial situational update. This standard template should only include information needs required for all medical-system responses regardless of nature and etiology. The information request should be derived after input from all stakeholders in the medical system and should consider the amount of effort required of the facility or organization providing the information. The requests should be simple and clearly understood; requiring explanation will either delay delivery of the information or produce inconsistent and questionable results. It may be better to

ask a hospital the anticipated number and type of ventilators that may need to be supplied from the outside, rather than requiring a total inventory of every ventilator—a number that will be outdated before it reaches its end destination. The information requested should be quantifiable, similar to the HOSS example provided above.

Such an information template currently exists. The USDHHS routinely requires a select amount of information through its HaVBED reporting system. Recently, in anticipation that the H1N1 pandemic could create system problems, the HaVBED system reporting requirements were significantly expanded, without any serious consultation with the end providers or state health agencies.[75] This "top down" approach, combined with the lack of an MOC network for collection and collation, has resulted in a hardship on the end provider, a low level of compliance, subjective data that may not be comparable from one region to the next, and difficulty for the states in collecting additional information they may feel is important for the management of the medical system during the pandemic.

Fortunately, a definition of the external vertical segmentation currently exists and is in widespread use in the medical-planning and response community. The Medical Surge Capacity and Capability Project (MSCC) provides a description of the vertical integration of the medical system during a complex medical or public-health response. The goal of the project is to "develop a management system (framework) that promotes public health and medical system resiliency and maximizes the ability to provide adequate public health and medical services during events that exceed the normal medical capacity and capability of an affected community.[76] Key components of the system include:

- Defining a system that includes management of local, state, tribal, and federal medical response to provide optimal surge capacity and capability, while protecting health-care staff, current patients, and the health-care system integrity;

[75] United States Department of Health and Human Services, "HaVBED Users Guide (DRAFT)."

[76] United States Department of Health and Human Services. *Medical Surge Capacity and Capability.*

- Defining the management relationship between health care organizations and provider, and the multiple levels of government response;
- Establishing incident-planning processes and information management to promote an integrated medical response that is timely and accurate;
- Incorporating incident command system principles to facilitate medical-system integration with non-medical incident management during response, and to establish acute-care medicine as "first responders" in the emergency-response community. Providing a platform for effective training of medical incident management and response, from the local to the federal response levels.[77]

The MSCC focuses on the integration of existing programs for incident management used by the medical system and calls for an emphasis on specific functionalities in order to provide a "systematic approach to organize and coordinate available public health and medical resources so they perform optimally under the stress of an emergency or disaster."[78]

The MSCC vertically segments the medical system response into six levels, starting with the individual health-care organization and ending with the overall federal response. These levels of response correlate nicely with the proposed MOC network.

An excellent example of the horizontal segmentation of the medical system and its relationship with public-health activities and other supportive response agencies can be found in the Medical and Health Incident Management System (MaHIM) authored by Drs. Barbera and Macintyre in December of 2002.[79] The MaHIM system utilizes an incident command system–based structure to organize response activities based upon select functional areas. The system also incorporates both public-health activities as well as those required of the medical system. The operational section of the system breaks these activities into six key areas:

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[77] United States Department of Health and Human Services. *Medical Surge Capacity and Capability.*

[78] Ibid.

[79] Barbera and Macintyre, *Medical and Health Incident Management (MaHIM) System.*

- Incident epidemiological profiling;
- Pre-hospital care;
- Medical care;
- Mental health;
- Hazard/threat/disease containment;
- Mass fatality. [80]

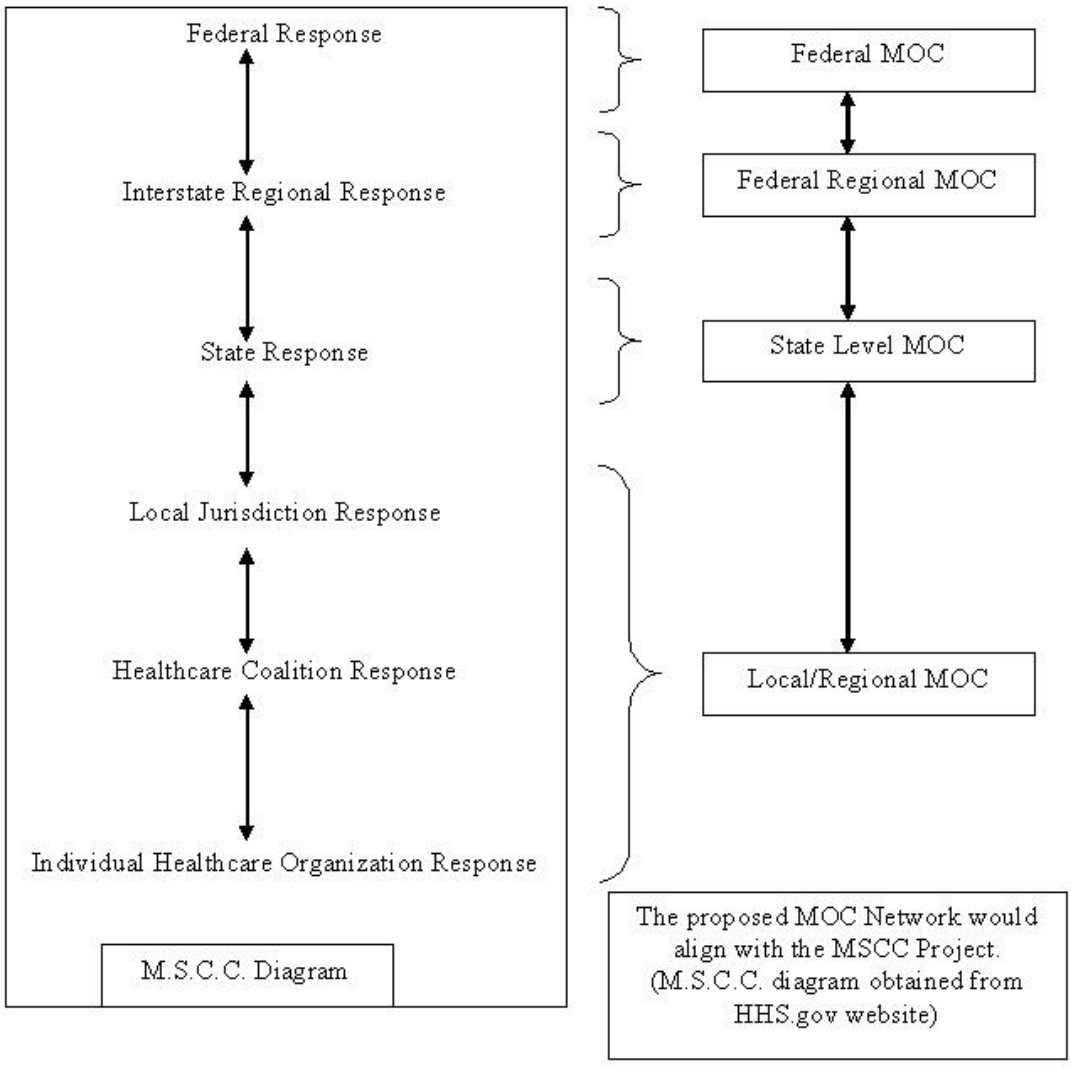

Figure 5. Proposed Network of MOCS Aligned with Medical System Response

[80] Barbera and Macintyre, *Medical and Health Incident Management (MaHIM) System.*

Of these six areas, two—epidemiological profiling and disease containment—can be considered public-health activities. Two others—pre-hospital care and medical care—are clearly medical-system activities. The remaining two—mental health and mass fatality—can be performed by either the public-health or the medical system. The authors of the MaHIM system recognized the distinct differences between medical and public-health systems as well as their intertwined relationships.

Each one of the functional areas is broken down further to a list of subfunctions. For example, the medical care functional area is broken down into the following sub-functional areas:

- Acute medical care (the traditional evaluation and treatment capabilities for injury and illness);
    - Out-of-hospital care (outpatient services, physician offices, and other practitioners of health care);
    - Emergency and hospitalized care (emergency department and hospital care).
- Post acute medical care (chronic and long-term care, rehabilitation services, home health care, special-needs patients);
- Patient diagnostics (laboratories, radiology);
- Medical evacuation and inter-facility transport (ground, rotary, and fixed-wing transport services). [81]

By determining which agencies and organizations perform these patient-care-related functions within a region, the MOC can identify the horizontal matrix of the agencies and organizations that will need coordination during a mass-casualty incident or public-health emergency.

The MaHIM system also identifies the non-medical agencies and organizations, by function, with which an MOC will need to coordinate in order to accomplish an effective medical response. These include the following organizations:

[81] Barbera and Macintyre, *Medical and Health Incident Management (MaHIM) System.*

- Fire suppression;
- Scene security/perimeter control;
- Search and rescue;
- Traffic control;
- Hazardous material response;
- Law enforcement;
- Mass evacuation;
- Public works and engineering.

The MOC will likely work through the local, regional, or state emergency management agencies, emergency operations centers, or scene-based incident command systems in order to have these functions performed in support of a medical response, but there may be times where there is direct communication and coordination between an agency performing the function and the MOC.

6. Information Management Network

The MOC system has been described in terms of functional areas of operation as well as the vertical and horizontal stratification of the agencies and organizations involved in a medical response. An effective information-management system is required to link those disparate components together in order to facilitate an effective response. This system will oversee the acquisition, analysis, formatting, and distribution of information in support of the operations section of the MOC as well as the various agencies involved in the response.

The authors of the MaHIM system provide both insight and an innovative approach to the information-management needs of a medical-response structure. The MaHIM system structure provides for a medical local information function in the planning section. This function "establishes overall coordination of information by specifying the data to report, and establishing reporting requirements such as formatting, timing, and methodologies." [82] As noted earlier, these templates and reporting

[82] Barbera and Macintyre, *Medical and Health Incident Management (MaHIM) System.*

requirements need to be determined before a communication network is established; they should drive the design and selection of the communication technologies. Too often, a type of technology, in the form of a radio system, satellite system, or incident management software, will already be in place prior to the building of the network. There will be an attempt to utilize the systems that already exist, regardless of capability or initial design intent in order to justify the expense of the software program. The result is often an attempt to drive a square peg of need into a round hole of capability with the end product questionable in usefulness and validity.[83] The jurisdiction or agency taking this approach may have little choice due to time or fiscal realities. However, whenever possible, the approach should always be to determine the information management needs first, and then procure the necessary technology to respond to those needs.

This is even more critical when building a network of MOCs; the information-management processes and linkage between the various MOCs at different levels is the gluethat holds the network together. The necessary time and funding should be appropriated to ensure that information management is robust, consistent, and transferable between the various components of the MOC network.

7. What is in a Name?

There are several MOCs in the nation operating under different names. Table 21 shows some of the names of these MOCs:

Table 21. Current MOC Names.

Selection of Current Names for a Medical Operations Center Currently in Use	
Medical Operations Center	Medical Emergency Resource Center
Regional Medical Operations Center	Regional Health Information Center
Medical Information Center	Catastrophic Medical Operations Center
Medical Emergency Response Center	Medical Emergency Operations Center
Medical Resource Control Center	Emergency Care Control Center

[83] An example of this phenomenon is the current HaVBED requests being processed through a notification and resource management software program called EMResource. The software program is in wide use by public health and medical system agencies and organizations. However, the HaVBED report requires thirty-two data points, while EMResource can only manage twenty data points in a single report. Consequently, hospitals have to fill out two separate questionnaires in order to generate one report.

While it would be inherently unfair and realistically impossible to call for a specific name change for all of the MOCs, there should be agreement on the name of the entity that performs the functions of medical-system coordination. I have used the term medical operations center in this thesis to describe that function, and I feel that this term best meets the needs for a standardized descriptive name. Anecdotally, the term medical operations center also seems to be working its way into the vernacular of the emergency-response community. Each MOC can adopt or keep whatever official name it desires, but the overall name for the entity would be an MOC. This seemingly trivial differentiation may prove important during a response. Federal, military, or state EMAC medical teams coming into an area will need to obtain medical intelligence and establish their presence within the medical response infrastructure. They will need to seek out the MOC, and would be better served if they could request the location and contact information for an entity with a standardized name, rather than trying to describe the functions of the MOC or figure out the local or regional name for the entity.

E. WHAT THE NETWORK WILL LOOK LIKE

A visual depiction of the MOC network will assist in understanding what is needed to facilitate a medical response to a large-scale incident or catastrophe in this country. I have outlined the need for a functions-based network, described the vertical and horizontal segmentation of the system and how the network relates, and discussed the need for a robust information management system to tie the network together. The following schematics will provide another way to demonstrate how the system could be built.

1. The Regional MOC

This is the basic building unit of the national network. Even though there may be political or other pressures to keep the MOC in a particular jurisdiction, the MOC should be regional and match the geographic scope of the existing medical system. The regional MOC may perform both public-health and medical system response functions, or may have to liaison with a public-health agency's coordination center if such an entity exists.

The regional MOC will also have to perform a liaison function with at least one emergency operations center, and likely several. The informal communication pathway between this regional MOC and another located elsewhere in the state is also depicted.

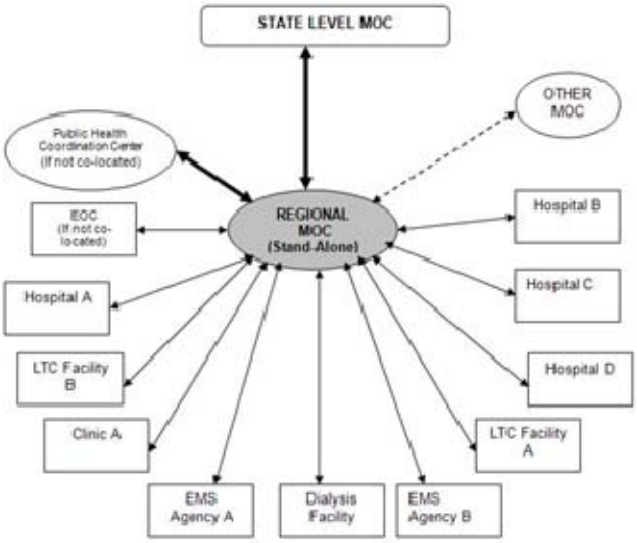

Figure 6. The Regional MOC

2. The State-Level MOC

The state MOC serves as a critical link in the MOC network and must perform two important functions during a large medical response affecting the state. The state MOC must interact with the regional MOCs that have been activated and coordinate a multiple, regional, medical-system response.

Figure 7. The State-Level MOC

The state MOC must also act as a conduit of information between the federal and regional coordination entities. The state MOC will likely also be required to coordinate public-health activities occurring within the medical-system response. The state MOC will have a direct relationship and a communications pathway with each of the activated regional MOCs. There will also be a direct relationship with either a national or a federal regional MOC, depending on how the federal part of the national network has been structured. The dotted lines on the diagram depict either the informal or formal communication pathways between each of the individual regional MOCs. The state MOC must recognize and accept these communication pathways, while the regional MOCs must recognize, accept, and facilitate the state MOC's need to be the centralized hub for information should a disaster involve multiple regions in the state.

3. The Federal MOC and the Overall National Network

The last level of the network consists of the federal components that will be placed into operation during a mass casualty or public-health emergency. The federal government, namely USHHS, will need to decide whether it wants to coordinate from one centralized coordination center or to employ the use of a regional MOC in each of the federal regions. Currently, the coordination effort is performed at the Assistant Secretary of Health and Human Services (ASPR) Operational Center, located in Washington, D.C. This center is part of the Emergency Care Coordination Center established in response to

HSPD-21.[84] If the MOC network is completed to its fullest extent, the ASPR Operations Center will need to coordinate the activities of between fifty to fifty-six state and territorial MOCs. This may present a span of control issues during a significant national emergency such as a virulent pandemic. The ASPR Operations Center in Washington, D.C. would need to ensure that space and staff were available to address the significant level of information management that would be required during such an event.

Another option would be to establish a federal MOC in each of the ten federal regions in the nation. Each state MOC would coordinate with the federal regional MOC in the region, and each federal regional MOC would, in turn, interface with the ASPR Operations Center in Washington, D.C. While this would certainly address the span-of-control challenge, it would also add additional cost to the network and would insert another level of complexity and bureaucracy to the management of information, command, and control. The decision on which model to adopt will need to be made by the leadership at USHHS, but I favor a single robust and capable ASPR Operations Center in Washington with internal sections for each federal region. The network needs to be as lean and efficient as possible to facilitate the rapid analysis and distribution of information; adding another level of complexity could create a potential bottleneck for the information flow.

Figure 8 presents the national MOC network in schematic form. Each regional MOC coordinates with its respective state MOC. There is also an informal communications pathway between and among the regional MOCs represented by the dashed lines. Each state MOC in turn either coordinates with the federal regional MOC, if that option is chosen by USHHS, or directly with the ASPR Operations Center in Washington, D.C. Like the regional MOCs, there will likely be an informal communications pathway between State MOCs, identified by the dashed lines. In total, one hundred fifty to two hundred regional MOCs will coordinate with fifty to fifty-six state and territorial MOCs. Those state and territorial MOCs will either coordinate with ten federal regional MOCs or with one large federal MOC located in Washington, D.C.

[84] United States Department of Health and Human Services, “Emergency Care Coordination Center.”

The network allows for an effective two-way management of information at all levels of response during a disaster or public-health emergency.

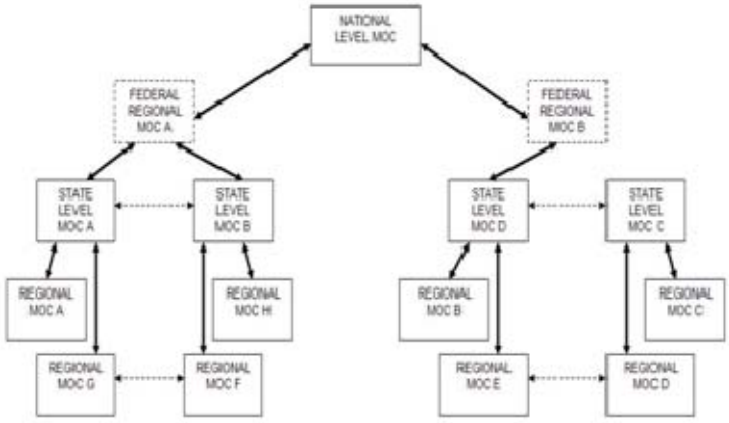

Figure 8. The National MOC Network

The national network of medical operations centers not only can be built, but it should be built. Many MOCs currently exist, and many more are likely to follow; the capabilities of each would be greatly expanded if they were formed into a cohesive network. A comprehensive means of gathering and disseminating critical medical-system information could be done relatively easily with the right leadership, authorities, and consistent functionalities. The MMRS program, or even the UASI and/or ASPR Grants offer already functioning programs that could oversee and coordinate the development of an MOC national network. An MOC could be established with a minimal amount of funding and could be staffed and operated in a cost-efficient manner.

This spring, the United States was faced with the first pandemic of this century when the 2009 H1N1 influenza virus appeared. The operational MOCs in the country went to work and coordinated the medical-system response. Hospital capacities were monitored, PPE and other resources were distributed, and critical information was relayed from public-health authorities.

The nation faces another wave of the pandemic this fall and winter combined with the annual seasonal influenza. Medical-response agencies and organizations are gearing up to weather the gathering storm. In order to achieve a greater situational awareness during this period, USDHHS has significantly expanded the data elements that hospitals

are required to report to the HaVBED system. This sudden expansion has created some difficulty for the hospitals regarding the processes for reporting. So far, hospital compliance has been haphazard, and the information obtained has been spotty at best. While the HaVBED system may eventually succeed in obtaining the needed information, a functioning medical operations center network would be able to provide both the state and federal government with any information needs that might present during the course of the pandemic. It may too late for the network to be built in time to affect the current pandemic response, but if the federal government, the states, and local jurisdictions start now, perhaps we can have a functioning network in time for the next widespread disaster, which we know is only a matter of time. The time to start is now.

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VI. CONCLUSION

Four years after Alan Paxton lay untreated in one hospital while a nearby center remained underutilized, another large tornado once again struck Oklahoma City. On May 9, 2003, experienced storm chasers following the nighttime tornado reported a large funnel cloud passing through densely populated neighborhoods and striking two large hospitals. The public-safety response was massive, expecting the levels of damage, injury, and death experienced in 1999. The Oklahoma City Medical Emergency Response Center (MERC), already activated with the approach of the storm, immediately checked the status of the two affected hospitals and began collating reports of EMS volume and the number of patients referring into the emergency departments of the hospital system. The affected hospitals reported minor damage: the loss of air conditioning at one location, minor roof damage at another. Both hospitals remained functioning. The emergency departments in the system were not seeing an influx of tornado victims. Relatively few EMS calls were being dispatched for tornado-related injuries. The information collated by the MERC was shared with the incident command structure and public-safety resources assigned to the incident were significantly reduced and/or released. The next morning revealed small and isolated areas of damage. The tornado had been large and powerful, but the damaging winds had not gone down to ground level until the storm was well past the metropolitan area.

The MERC's actions showed the value of a medical operations center's ability to quickly assess the medical system and provide rapid and reliable information to the response infrastructure. This processed and analyzed intelligence can prove quite valuable to decision makers during a disaster or terrorism event.

The summary of this thesis is organized around five core themes: the need for medical operations centers, the separate but linked medical and public-health systems, the need for collaboration and incident management, challenges and solutions, and the need to tie all the current and new centers coming online into a national network.

1. The medical system is a complex network of agencies and organizations that would be better served by a medical operations center to facilitate coordination and information flow during a mass-casualty incident or pubic health emergency.

The medical system provides a cradle-to-grave continuum of care for individuals, beginning with prenatal care and concluding with hospice care for the terminally ill. Included in this continuum are hospitals, EMS agencies, outpatient clinics, dialysis centers, physicians' offices, pharmacies, rehabilitation centers, mental-health clinics, hospices, and medical-equipment suppliers. These different organizations work together in a complex networked system of competition, regulation, third-party payment, cost shifting, and economic uncertainty. Most of the system is privatized and outside the public domain. Yet it is this system that is called upon to address the most critical element of a natural disaster or terrorist attack: reducing the mortality and morbidity of the affected population.

Medical providers are heavily dependent on infrastructure, technology, and personnel. The medical system, through decades of cost-containment strategies, has eliminated most of its excess capacity in the name of efficiency. The medical system does have the capability to adapt to changes in the external environment from regulation, payment changes, and technological and clinical advances, but this adaptation is slow. A sudden surge in patients from a mass-casualty incident or the degradation of the supporting infrastructure will require a medical operations center to effectively coordinate the necessary resources, information, and personnel. This will not only optimize the utilization of the medical system in the response phase but ensure its survival and availability to the community after the incident.

2. The medical system is markedly different from the public-health system, but the two are not mutually exclusive, and they combine to form the overall health-care response to the community during a disaster or public-health emergency.

As noted earlier, both the focus groups and the survey demonstrated that there is a clear distinction and difference between the medical system and the public-health system. This difference is also delineated in HSPD-21 and other recent documents. The medical

system focuses its attention on individual care, while the primary focus of the public-health system is the overall health of the community. Medical-system providers often have to make decisions and act upon partial information and an incomplete picture. Public-health providers prefer to obtain as complete a picture as possible before acting—a necessary approach when the recommendations and actions have significant ramifications for a large number of people.

Although the two systems are different, they cannot and do not operate in separate silos. Medical-system providers routinely perform public-health functions, such as syndromic surveillance and infectious-disease intervention. Likewise, the public-health community engages in individual care through monitoring infectious patients and providing guidance to clinical providers. Each component in each system usually performs at least some function of the other. The difference lies in the priority, scope, and decision process. Although the focus groups and survey participants felt strongly that the systems were indeed different, they opposed just as strongly the separation of ESF-8 into two separate functions. As one participant put it, “They are different systems, but they are both under the umbrella of health care.”

3. Regional planning, collaboration, and an effective incident-management system needs to accompany the development of a medical operations center in order to effectively respond to any incident that creates a large number of ill or injured.

The medical operations center cannot operate in a vacuum. In order to be successful, the formation of a center must be accompanied by local and regional planning with all the stakeholders present. Preferably a neutral entity will bring together key agencies and individuals to identify gaps and arrive at mutually agreed-upon solutions. There must be an effective incident-management system, such as the MaHIM system developed by Drs. Barbera and Macintyre. This system will need to be ingrained in both the medical and public-health systems and then exercised on a regular basis. In order to foster the effective collaboration needed for the development of a medical operations center, there must be identified funding sources, a clearly stated purpose and mission, buy-in from hospital executives and agency heads, and value perceived by participating organizations.

4. Challenges to creating a medical operations center are numerous, but can be overcome through the application of funding, collaboration, and the provision of added value to the stakeholders.

The focus groups and survey responses revealed that numerous obstacles exist to the creation of a medical operations center. These obstacles include a lack of funding, lack of space, competing city and regional priorities, a perception of duplication by emergency management, lack of statutory ordinance or authority, and lack of a clear organization to oversee the center. While some of these challenges are certainly difficult, they are not without solutions.

Funding for the initial costs of a medical operations center can be found from numerous USDHS and USDHHS grant programs. These programs include the MMRS program, UASI, ASPR, and CDC, as well as specific funding programs for EOC operations. A case can be made that the centers will facilitate interoperable communications within the medical community. Once the value of the centers is demonstrated to the medical and public-safety community, sustainment sources may be easier to identify. Medical operations centers can exist anywhere that there is space. Location within an EOC is favorable, but that may not be an initial option. The hospital system may be able to find space, or the functions of an MOC can be incorporated into an existing structure such as a medical call center. Once the value of the center is demonstrated, space will likely become available.

The perception of duplication by emergency managers can be overcome through education and the practical demonstration that the MOC is there to augment, not replace, an EOC. Clear authorities are not necessary if a facilitative approach is taken and can be created or identified should they become necessary. Any number of organizations can oversee the MOC. With a true collaborative effort the oversight function becomes one of administration, while the medical community, through regional planning and the provision of staffing, actually operates the center to meet its needs.

5. Medical operations centers at the local, regional, and state level continue to be developed in numerous jurisdictions across the country. A minimal level of

consistent functionality and a national framework must be established to facilitate the optimal coordination and information flow at the local, state, and national level.

An opportunity currently exists to establish a national system of medical operations centers at the local, regional, state, and national level. Many jurisdictions around the country have recognized the need for medical-system coordination and have taken active steps towards the creation of a medical operations center. The four centers presented in this thesis are representative examples, used to highlight some of the different approaches and challenges to establishing an MOC. There are many different variations of centers currently underway. Based upon the research, the MOC should be operated together with any public-health operations center. The MOC should also be located within an EOC. These ideal situations are not always possible for many reasons so there cannot be a cookie-cutter standardized layout for any particular jurisdiction. Each jurisdiction or region must take into account its own needs, challenges, and solutions in developing an MOC.

What can be standardized is the funding, core functionality, and connectivity of the medical operations centers, and the establishment of a national network of the centers at the regional, state, and local level. Homeland Security and Health Preparedness funding can be specifically targeted towards the creation of MOCs through the country. Along with the funding, USDHS and USDHHS can establish the core functions needed for a large-scale event. These functions might include situational awareness, medical intelligence, communications, and resource prioritization. Many of these functions already exist in grant requirements, just not in the context of a medical operations center.

Several states have already established a network of medical and public-health operations centers within their own borders. These individual networks can be connected both vertically and horizontally to form a national infrastructure of medical system coordination and communication that stretches across the various MSCC tiers. The example provided demonstrates how USDHS and USDHHS would have a structure to roll up information from the various states into a common operating picture. The federal government would also have a means of sending information and intelligence downstream, being assured that it would reach the local and regional level. The

horizontal connectivity may be controversial and appear to subvert established authoritarian lines, but this will likely happen spontaneously. Horizontal connectivity will also build in a degree of redundancy and security by forming a leaderless organization that can still function and obtain information should the main connecting node fail. Prescribed vertical communications can still be required, but horizontal communication should be encouraged.

A key to establishing this network will be constant awareness of the nature of the medical system at the local and regional levels. The system is stressed, complicated, and comprised of many moving parts. The system is also keenly aware of its role in homeland security and offers significant resources to address coordination. Any successful system will need to provide value to both local/regional jurisdictions and the local/regional medical system.

VII. RECOMMENDATIONS FOR FURTHER RESEARCH

Since the concept of a medical operations center is a relatively new construct for emergency planners, and a national network of such centers has not been discussed in the literature, a significant amount of academic research still needs to be done. First, a more complete inventory should be conducted on current medical operations centers currently and their methods of operation. Since the research for this thesis involved focus groups from jurisdictions with an MOC in place, the same type of research should be conducted in jurisdictions without an operating MOC. Research needs to be conducted on the subject from the public-health point of view.

There must be additional research on the dichotomy and necessary integration strategies between the public-health and medical systems since they are markedly different, but there is a preference to keep the medical system and public-health coordinating activities together. There is a need for additional empirically based retrospective reviews of past disasters and public-health emergencies from the prespective of medical-system coordination. Lastly, the ESF-8 criteria need to be examined further to determine whether they meet the needs of the medical system, the public-health system, and the medical special-needs patients.

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